THE UNITED STATES OF AMERICA

PUBLIC WORKS

AND REGISTER

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BUILDING FOR LIBRARY OF CONGRESS. NOVEMBER, 1894.

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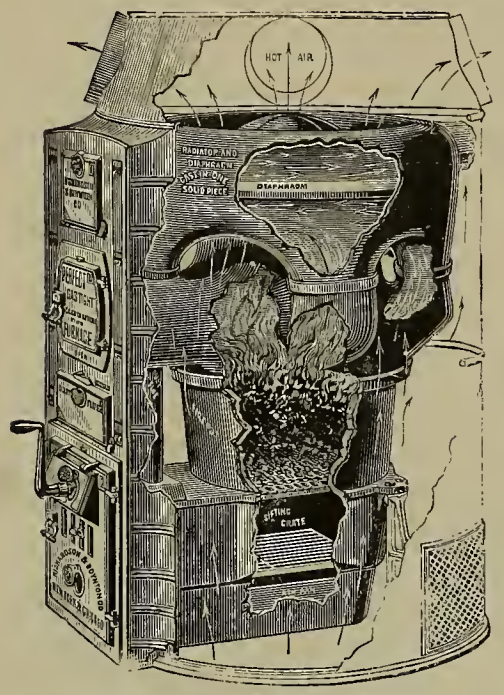

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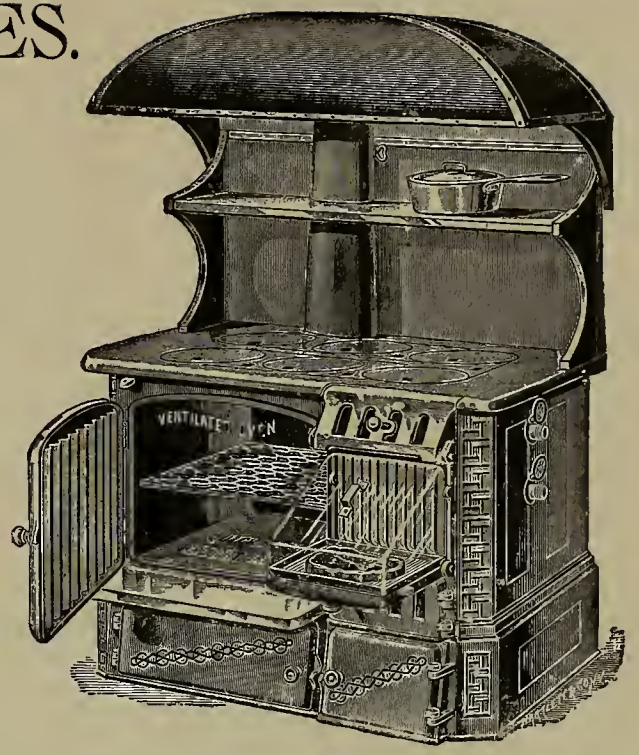

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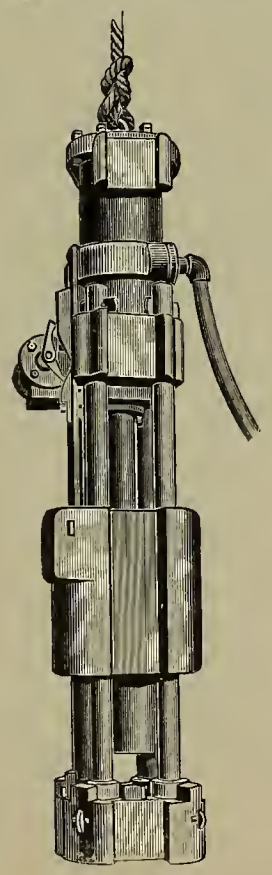

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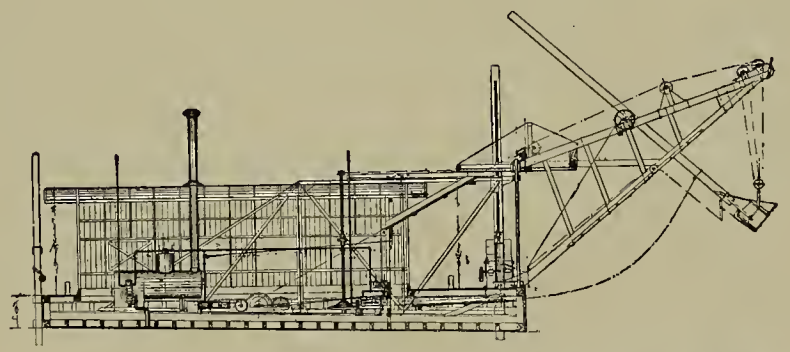

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No. 1	12 × 14 "	1200 to 1500
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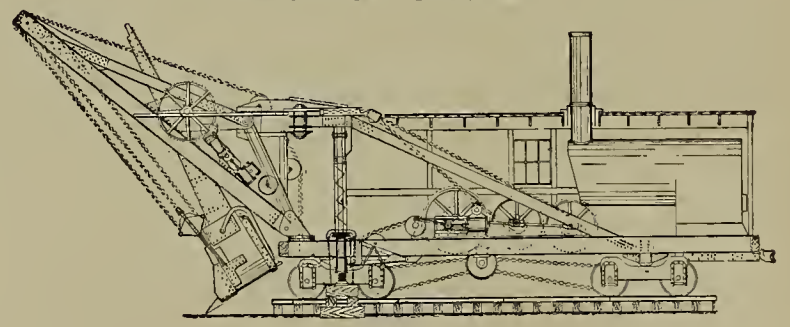

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THE UNITED STATES PUBLIC WORKS.

CONTAINING A SUMMARY OF THE

METHODS OF CONSTRUCTION AND CHARACTER OF MATERIALS AND PLANT

USED IN THE PUBLIC WORKS UNDER THE CHARGE OF THE WAR AND TREASURY DEPARTMENTS, AND OF THE COMMISSIONERS OF THE DISTRICT OF COLUMBIA, INCLUDING WORKS OF RIVER AND HARBOR IMPROVEMENT, BUILDINGS AT POSTS OF THE UNITED STATES ARMY, LIGHT-HOUSES, PUBLIC BUILDINGS, LIFE-SAVING STATIONS, AND WORKS OF MUNICIPAL ENGINEERING OF WASHINGTON, D. C.;

ALSO OF THE

LAWS, REGULATIONS, AND FORMS PRESCRIBED FOR THE CONDUCT OF SUCH WORKS;

AND

A DIRECTORY OF THE UNITED STATES AGENTS IN CHARGE OF THESE WORKS, AND OF CONTRACTORS FOR THEM, ALSO OF MANUFACTURERS OF AND DEALERS IN MACHINERY, MATERIALS, AND MISCELLANEOUS SUPPLIES USED IN THE CONSTRUCTION OF THE WORKS.

PUBLISHED AS A BOOK OF REFERENCE FOR ALL PERSONS INTERESTED IN THE PUBLIC WORKS, AND FOR ENGINEERS AND CONTRACTORS IN GENERAL.

BY

CAPTAIN W. M. BLACK,

Of the Corps of Engineers of the United States Army, Member of the American Society of Civil Engineers.

Illustrated by over forty Photogravures and Working Drawings.

NEW YORK:
JOHN WILEY & SONS,
53 EAST TENTH STREET.
1895.

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INTRODUCTION.

"Public Works," as defined by the "Century Dictionary," are "all fixed works constructed for the public use, . . . ; more strictly, military and civil engineering works constructed at the public cost." In the following pages the limits of the term will be extended slightly, to include buildings erected for the public use.

The public works of the United States are in charge of agents working under different bureaus of the executive departments of the Government, and are carried on either by hired labor or by contract. New works are being started and old works are demanding repair daily. In all cases the agent of the United States charged with the work wants to know where the needed supplies can be obtained best, or where he can find experienced, responsible men, prepared to undertake the class of work required. At the same time, while the large body of merchants, manufacturers, and contractors know in a general way that large sums are expended annually by the Government for the very material or labor which they are prepared to offer, they are deterred from bidding for them through ignorance of the exact nature of the materials or work, and of the methods for placing their offers before the proper agent.

It is the design of this book to show the prescribed business methods of those of the executive departments which most largely control the classes of Government work defined in the first paragraph; to describe briefly the nature of the works and the plant and materials most largely required; and to give a directory of Government agents, and of the larger supply-houses, manufacturers, and contractors.

The subject thus includes the methods and work of the Corps of Engineers and Quartermaster's Department of the Army under the War Department; of the Lighthouse Establishment, Life-saving Service, and Supervising Architect's Office under the Treasury Department; and of the officers charged with the public works in Washington.

The operations of these departments cover works of fortification; works for the improvement of rivers and harbors; construction of barracks and quarters at army posts; construction and maintenance of lighthouses and beacons, of life-saving stations, of Federal buildings; and the works of municipal engineering of Washington.

It is not proposed to describe or to discuss the interior economy of the departments, or the relations between the agents of the United States and their immediate superiors, but only to give the methods and limitations prescribed by law and regulation for the government of these agents in their business with the public. To this end, to eliminate errors due to personal interpretation, the extracts from the United States Revised Statutes and the official regulations directly applicable are given in exact terms as far as possible.

In the first chapter are found the general laws and regulations under which all of the public works are carried on; in the succeeding chapters are given a brief description of the departments, in turn, with the special laws and regulations for work under each, and a description of the works carried on by them. Following these chapters are copies of the official forms of each department, and last are the directories.

The laws and regulations are grouped by subjects. Typical works of less well-known classes are described in detail, with photo-

graphic illustrations and detail drawings. Working methods, plant, materials, and arrangement of gangs are described; and itemized tables of costs are given whenever such items seemed sufficiently novel or valuable. These items are scattered under the subheads to which they refer, but are made available for general use by the Index.

The book does not treat of engineering principles, but it is hoped that in the descriptions of the work and plant the engineering profession at large will find matter of interest and value.

In preparing the matter for this book, the compiler has been compelled to seek information and aid from many of his fellow agents of the United States. In every instance the assistance asked for has been given promptly and courteously, and the most valuable portions of the text are the result. He desires particularly to express his obligations to Major Raymond, Captains Marshall and Rossell and the late Captain Price of the Corps of Engineers, and to Mr. E. V. Kemper, Chief Executive of the Office of the Supervising Architect, Treasury Department.

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ABBREVIATIONS.

A. R. United States Army Regulations.
E. D. Engineer Department, U. S. Army.
E. R. Regulations for the Government of the Corps of Engineers, U.S.A.
L. H. R. Regulations relating to the Light-House Establishment.
L. S. S. Life-Saving Service.
Q. M. D. Quartermaster's Department, U. S. Army.
Rep. C. of E. Annual Report of the Chief of Engineers, U.S.A.
R. S. United States Revised Statutes.
S. A. O. Supervising Architect's Office.
Trans. Am. Soc. Civ. Eng. or T. A. S. C. E. Transactions of the American Society of Civil Engineers.

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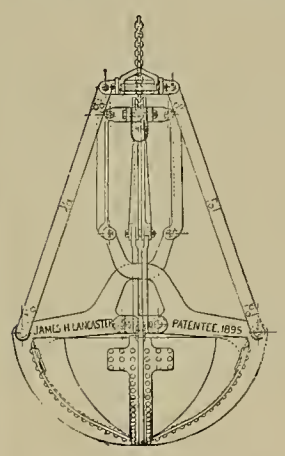

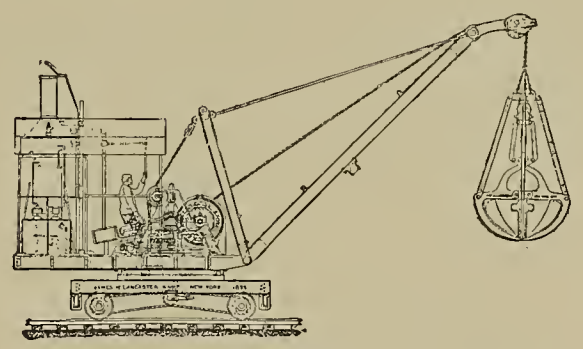

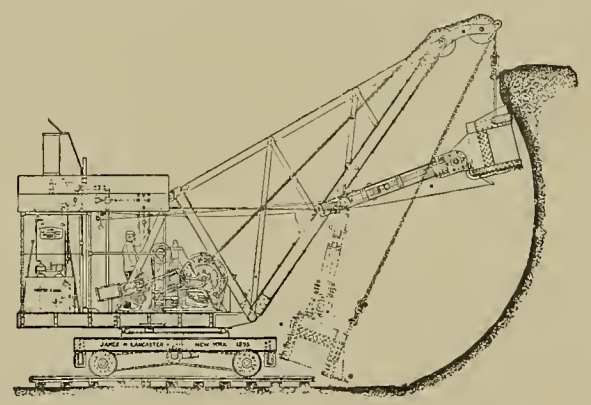

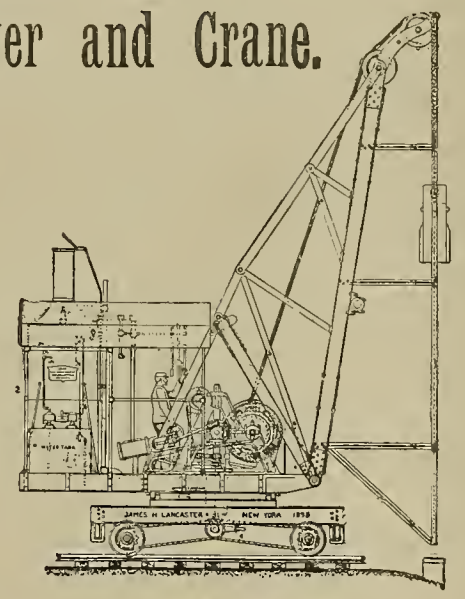

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UNITED STATES PUBLIC WORKS.

CHAPTER I.

GENERAL LAWS AND TREASURY REGULATIONS.

APPROPRIATIONS, LABOR AND MATERIALS.

Application of Appropriations.—Disbursing officers are held strictly accountable that all appropriations are applied to the objects for which they are made and to none other; that no liabilities are incurred beyond the sums allotted or appropriated for the several works; and that the expenditures in any fiscal year shall be paid from and do not exceed the appropriations available for that year. (Secs. 3678, 3679, 3690, 3733, 5503, R. S.)

Voluntary Service.—Officers are forbidden to accept voluntary service for the Government except in cases of sudden emergency involving the loss of life or destruction of property. (Act May 1. 1894.)

Alien Labor.—The importation and migration of foreigners and aliens under contract or agreement to perform labor in the United States, its territories and the District of Columbia is forbidden. (Acts of Feb. 26, 1885, and Feb. 23, 1887.)

Eight Hour Law.—Except in cases of extraordinary emergency the services of laborers and mechanics employed on any of the public works of the United States are limited and restricted to eight hours in any one calendar day. (Act Aug. 1, 1892.)

Liability for Materials and Labor Furnished for Public Works.—"Hereafter any person or persons entering into a formal contract with the United States for the construction of any public building, or the prosecution and completion of any public work or for repairs upon any public building or public work, shall be required before commencing such work to execute the usual penal bond, with good and sufficient sureties, with the additional obligations that such contractor or contractors shall promptly make payments to all persons supplying him or them labor and materials in the prosecution of the work provided for in such contract; and any person or persons making application therefor, and furnishing affidavit to the Department under the direction of which said work is being, or has been, prosecuted, that labor or materials for the prosecution of such work has been supplied by him or them, and payment for which has not been made, shall be furnished with a certified copy of said contract and bond, upon which said person or persons supplying such labor and materials shall have a right of action, and shall be authorized to bring suit in the name of the United States for his or their use and benefit against said contractor and sureties and to prosecute the same to final judgment and execution: *Provided*, That such action and its prosecutions shall involve the United States in no expense.

"Provided that in such case the court in which such action is brought is authorized to require proper security for costs in case judgment is for the defendant." (Act Aug. 13, 1894.)

PURCHASE OF LAND.

Purchase of Land.—"No land shall be purchased on account of the United States except under a law authorizing such purchase." (Sec. 3736, R. S.)

Condemnation of Land.—"In every case in which the Secretary of the Treasury or any other officer of the Government has been, or hereafter shall be, authorized to procure real estate for the erection of a public building or for other public uses he shall be, and hereby is, authorized to acquire the same for the United States by condemnation, under judicial process, whenever in his opinion it is necessary or advantageous to the Government to do so.

"And the United States circuit or district courts of the district wherein such real estate is located, shall have jurisdiction of the proceedings for such condemnation, and it shall be the duty of the Attorney-General of the United States, upon every application of the Secretary of the Treasury, under this act, or such other officer, to cause proceedings to be commenced for condemnation, within thirty days from the receipt of the application at the Department of Justice.

"The practice, pleadings, forms and modes of proceeding in causes arising under the provisions of this act shall conform, as near as may be, to the practice, pleadings, forms and proceedings existing at the time in like causes in the courts of record of the State within which such circuit or district courts are held, any rule of the court to the contrary notwithstanding." (Act Aug. 1, 1888.)

Title—Jurisdiction.—"No public money shall be expended upon any site or land purchased by the United States for the purpose of erecting thereon any armory, ... fortification, navy-yard, custom-house, light-house, or other public building, of any kind whatever, until the written opinion of the Attorney-General shall be had in favor of the validity of the title, nor until the consent of the legislature of the State in which the land . . . may be, to such purchase, has been given. . . ." (Sec. 355, R. S.)

"No light-house, beacon, public piers, or landmark, shall be built or erected on any site until cession of jurisdiction over the same has been made to the United States." (Sec. 4661, R.S.)

Consent of State.—"The President of the United States is authorized to procure the assent of the legislature of any State, within which any purchase of land has been made for the erection of forts, magazines, arsenals, dock-yards, and other needful buildings, without such consent having been obtained." (Sec. 1838, R. S.)

LEGAL HOLIDAYS.

Legal Holidays.—Per diem employees of the Government are allowed the following holidays: "the first day of January, the twenty-second day of February, the fourth day of July, the twenty-fifth day of December, and such days as may be designated by the President as days for national thanksgiving, and shall receive the same pay as on other days." (Joint Res. Jany. 6, 1885.)

"All per diem employees of the Government . . . shall be allowed the day of each year, which is celebrated as 'Memorial' or 'Decoration Day,' and the Fourth of July of each year, as holiday, and shall receive the same pay as on other days." (Joint Res. Feb. 23, 1887.)

"The first Monday of September in each year, being the day celebrated and known as Labor's Holiday, is hereby made a legal holiday, to all intents and purposes, in the same manner as Christmas, the first day of January, the twenty-second day of February, the thirtieth day of May, and the fourth day of July are now made by law public holidays." (Act June 28, 1894.)

PURCHASES AND CONTRACTS.

Advertisement for Proposals—Open Market Purchases.—"All purchases and contracts for supplies or services, in any of the Departments of the Government, except for personal services, shall be made by advertising a sufficient time previously for proposals respecting the same, when the public exigencies do not require the immediate

delivery of the articles or performance of the service. When immediate delivery or performance is required by the public exigency, the articles or service may be procured by open purchase or contract, at the places and in the manner in which such articles are usually bought and sold, or such service engaged, between individuals." (Sec. 3709, R. S.)

NOTE.—The act of January 27, 1894, amends sec. 3709, R. S., insofar as that section relates to the purchase of supplies for the Departments and Government establishments in the City of Washington, including the government of the District of Columbia, and provides that the proposals shall be opened at 2 p.m. on the same days in each Department and establishment, and that the schedules of bids and the proposed action thereon of the respective Departments and establishments shall be submitted to a specified board for recommendation as to acceptance or rejection.

Time for Opening Bids.—"Whenever proposals for supplies have been solicited, the parties responding to such solicitation shall be duly notified of the time and place of opening the bids, and be permitted to be present either in person or by attorney, and a record of such bid shall then and there be made." (Sec. 3710, R. S.)

Transfer of Contracts.—"No contract or order, or any interest therein, shall be transferred by the party to whom such contract or order is given to any other party, and any such transfer shall cause the annulment of the contract or order transferred, so far as the United States are concerned. All rights of action, however, for any breach of such contract by the contracting parties, are reserved to the United States." (Sec. 3737, R. S.)

Interest of Members of Congress in Contracts.—"No member of or delegate to Congress shall directly or indirectly, . . . undertake, execute, hold or enjoy in whole or in part any contract or agreement made or entered into in behalf of the United States, by any officer or person authorized to make contracts in behalf of the United States. . . . All contracts or agreements made in violation of this statute shall be void. . . ." (Sec. 3739, R. S.)

"Nothing contained in the preceding section shall extend, or be construed to extend, to any contract or agreement, made or entered into or accepted, by any incorporated company, where such contract or agreement is made for the general benefit of such incorporation or company; nor to the purchase or sale of bills of exchange or other property by any member of (or delegate to) Congress, where the same are ready for delivery, and payment therefor is made, at the time of making or entering into the contract or agreement." (Sec. 3740, R. S.)

"In every such contract or agreement to be made or entered into, or accepted, by or on behalf of the United States, there shall be inserted an express condition that no member of (or delegate to) Congress shall be admitted to any share or part of such contract or agreement, or to any benefit to arise thereupon." (Sec. 3741, R. S.)

Bribery of Government Officials.—"Every member of Congress or any officer or agent of the Government who, directly or indirectly, takes, receives, or agrees to receive, any money, property, or other valuable consideration whatever, from any person for procuring, or aiding to procure, any contract, office, or place, from the Government or any Department thereof, or from any officer of the United States, for any person whatever, or for giving any such contract, office, or place to any person whomsoever, and every person who, directly or indirectly, offers or agrees to give, or gives, or bestows any money, property, or other valuable consideration whatever, for the procuring or aiding to procure any such contract, office, or place, and every member of Congress who, directly or indirectly, takes, receives, or agrees to receive any money, property, or other valuable consideration whatever after his election as such member, for his attention to, services, action, vote, or decision on any question, matter, cause, or proceeding which may then be pending, or may by law or under the Constitution be brought before him in his official capacity, or in his place as such member of Congress, shall be deemed guilty of a misdemeanor, and shall be imprisoned

not more than two years and fined not more than ten thousand dollars. And any such contract or agreement may, at the option of the President, be declared absolutely null and void; and any member of Congress or officer convicted of a violation of this section, shall, moreover, be disqualified from holding any office of honor, profit, or trust under the Government of the United States." (Sec. 1781, R. S.)

"Every person who promises, offers, or gives, or causes or procures to be promised, offered, or given, any money or other thing of value, or makes or tenders any contract, undertaking, obligation, gratuity, or security for the payment of money, or for the delivery or conveyance of anything of value, to any officer of the United States, or to any person acting for or on behalf of the United States in any official function, under or by authority of any department or office of the Government thereof, or to any officer or person acting for or on behalf of either House of Congress, or of any committee of either House, or both Houses thereof, with intent to influence his decision or action on any question, matter, cause, or proceeding which may at any time be pending, or which may by law be brought before him in his official capacity, or in his place of trust or profit, or with intent to influence him to commit or aid in committing, or to collude in, or allow, any fraud, or make opportunity for the commission of any fraud, on the United States, or to induce him to do or omit to do any act in violation of his lawful duty, shall be punished as prescribed in the preceding section." (Sec. 5451, R. S.)

Sec. 5450, R. S., prescribes a fine of not less than three times the amount or value of the thing so offered, etc., and imprisonment for not more than three years.

Contracts Limited by Amount of Appropriation.—"No contract or purchase on behalf of the United States shall be made, unless the same is authorized by law or is under an appropriation adequate to its fulfillment, except in the War and Navy Departments, for clothing, . . . quarters, . . . which, however, shall not exceed the necessities of the current year." (Sec. 3732, R. S.)

"No contract shall be entered into for the erection, repair, or furnishing of any public building, or for any public improvement which shall bind the Government to pay a larger sum of money than the amount in the Treasury appropriated for the specific purpose." (Sec. 3733, R. S.)

Transfers of Claims.—"All transfers and assignments made of any claim upon the United States, or of any part or share thereof, or interest therein, whether absolute or conditional, and whatever may be the consideration thereof, and all powers of attorney, orders, or other authorities for receiving payment for any such claim, or of any part or share thereof, shall be absolutely null and void, unless they are freely made and executed in the presence of at least two attesting witnesses, after the allowance of such a claim, the ascertainment of the amount due, and the issuing of a warrant for the payment thereof. Such transfers, assignments, and powers of attorney, must recite the warrant for payment, and must be acknowledged by the person making them, before an officer having authority to take acknowledgments of deeds, and shall be certified by the officer; and it must appear by the certificate that the officer, at the time of the acknowledgment, read and fully explained the transfer, assignment, or warrant of attorney to the person acknowledging the same." (Sec. 3477, R. S.)

Powers of Attorney.—The following are extracts from a decision of the Comptroller of the Treasury, dated December 27, 1894, relative to powers of attorney. ". . . It, therefore, becomes necessary now to adopt a practice in regard to powers of attorney, which shall govern all the accounting officers of the Government. As in my opinion Sec. 3477 (Revised Statutes) prohibits the giving of such powers of attorney, . . . and as it is held in the Lopez case that it is in the discretion of the accounting officers whether they shall recognize such powers of attorney or not, in order to carry out the evident spirit of the section, I deem it my duty to refuse to approve any such powers in future.

"If disbursing officers in fact make payment to persons holding

unrevoked and undisputed powers of attorney, under the decisions of the Supreme Court in McKnight *v.* United States, 98 U. S., 179, and Bailey *v.* United States, 109 U. S., 432, and of the Court of Claims in the Lopez case, 24 C. Cls. R., 84, the accounting officers are necessarily compelled to allow the disbursing officers credit for such payments in the settlement of their accounts. In order, however, to give such credits it will be necessary to show that at the time payment was made there existed in favor of the person to whom payment was made, a power of attorney which, at the time, remained undisputed and unrevoked, either by the voluntary action of the grantor of the power or by his death.

. . . . . .

"Nothing in this letter is intended to affect payments to regular agents of corporations, the manner of payment in such cases being fixed by Treasury regulations."

PAYMENTS.

Unexpended Balances of Fiscal Year Appropriations.—"All balances of appropriations contained in the annual appropriation bills and made specifically for the service of any fiscal year, and remaining unexpended at the expiration of such fiscal year, shall only be applied to the payment of expenses properly incurred during that year, or to the fulfillment of contracts properly made within that year; and balances not needed for such purposes shall be carried to the surplus fund. This section shall not apply to appropriations known as permanent or indefinite appropriations." (Sec. 3690, R. S.)

Advance Payments.—"No advance of public money shall be made in any case whatever. And in all cases of contracts for the performance of any service, or the delivery of articles of any description, for the use of the United States, payment shall not exceed the value of the service rendered, or of the articles delivered previously to such payment. . . ." (Sec. 3648, R. S.)

"(1886. DEPARTMENT No. 157.)

"TREASURY DEPARTMENT, FIRST AUDITOR'S OFFICE,
"WASHINGTON, D. C., November 10, 1886.

"(REFERRING TO SEC. 3648 R. S.)

"This statute is mandatory and binding upon all who serve the Government for salary or fees; and also for all purchases of articles for delivery to the United States; carefully restricting payment made to amount of service rendered, or articles purchased and duly delivered before such payment.

"Hereafter, specific evidence of delivery of any and all articles purchased for the public use will be required for file with the vouchers presented to this office for audit.

"The rendition of a bill, with receipt, for moneys claimed as due for purchase made will not be deemed evidence of delivery in any case.

"Persons or corporations demanding payments in advance for gas, water, or other service, or supplies for the public use, are notified that, under the restrictive provisions of the statutes, no account can be certified by this office except for service, etc., rendered at the date of presentation of such account.

. . . . . .

"The certificate of delivery of property purchased for use of the United States will be required in all cases where practicable, duly signed by the legal custodian thereof. Where property is delivered to other parties than those above indicated for transportation, or for a subsequent delivery, the certificate will be signed by the actual custodian to whom delivered.

. . . . . .

"DANIEL MANNING, Secretary."

Time Limit for Appropriations.—"From and after the first day of July, eighteen hundred and seventy-four, and of each year thereafter, the Secretary of the Treasury shall cause all unexpended

balances of appropriations which have remained upon the books of the Treasury for two fiscal years to be carried to the surplus fund and covered into the Treasury: *Provided*, That this provision shall not apply to permanent specific appropriations, appropriations for rivers and harbors, light-houses,* fortifications, public buildings, and pay of navy and marine corps; but the appropriations named in this proviso shall continue available until otherwise ordered by Congress. . . ." (Sec. 5 Act Appd. June 20, 1874.)

Misapplication of Public Funds.—"If any officer charged with the disbursement of the public moneys, accepts, receives, or transmits to the Treasury Department to be allowed in his favor, any receipt or voucher from a creditor of the United States, without having paid to such creditor in such funds as the officer received for disbursement, . . . the full amount specified in such receipt or voucher, every such act is an act of conversion, by such officer, to his own use, of the amount specified in such receipt or voucher." (Sec. 5496, R. S.)

Outstanding Official Checks.—"At the termination of each fiscal year all amounts of moneys that are represented by . . . checks issued . . . by any disbursing officer of any Department of the Government . . . which have for three years or more remained outstanding, unsatisfied, and unpaid, shall be deposited by the Treasurer, to be covered into the Treasury by warrant, and to be carried to the credit of the parties in whose favor such . . . checks were respectively issued, or to the persons who are entitled to receive pay therefor, and into an appropriation account to be denominated 'outstanding liabilities.'" (Sec. 306, R. S.)

Payment of Old Outstanding Official Checks.—"The payee or the bona-fide holder of any draft or check, the amount of which has been deposited and covered into the Treasury pursuant to the foregoing sections, shall, on presenting the same to the proper officer of the Treasury, be entitled to have it paid by the settlement of an account and the issuing of a warrant in his favor, according to the practice in other cases of authorized and liquidated claims against the United States." (Sec. 308, R. S)

* Extract from decision of First Comptroller of the Treasury, July 17, 1874: "I do not understand this provision as extending to all appropriations for the Board, but only to those for construction and repairs."

PAYMENT OF TREASURY DRAFTS AND OFFICIAL CHECKS OF PUBLIC DISBURSING OFFICERS.

"TREASURY DEPARTMENT,
"OFFICE OF THE SECRETARY,
"WASHINGTON, D. C., April 21, 1891.

"(Sections 306, 7, 8, 9, and 10, R. S.)

"REGULATIONS.

"1. Hereafter any Treasury draft or any check drawn by a public disbursing officer still in service, which shall be presented for payment before it shall have been issued three full fiscal years, will be paid in the usual manner by the officer or bank on which it is drawn, and from funds to the credit of the drawer. . . .

"Any such draft or check which has been issued for a longer period than three full fiscal years will be paid only by the settlement of an account in this Department, as provided in Sec. 308, R. S. . . .; and for this purpose the draft or check will be transmitted to the Secretary of the Treasury for the necessary action.

. . . . . .

"5. In case of the death, resignation, or removal of a public disbursing officer, any check previously drawn by him and not presented for payment within four months of its date will not be paid until its correctness shall have been attested by the Secretary or Assistant Secretary of the Treasury.

"6. If the object or purpose for which any check of a public disbursing officer is drawn is not stated thereon, as required by departmental regulations, or if any reason exists for suspecting fraud, the office or bank on which such check is drawn will refuse its payment.

"These regulations are intended to supersede those of February 25, 1890, on this subject.

"CHARLES FOSTER, Secretary."

Official Checks Lost, Stolen, or Destroyed.—"Whenever any original check is lost, stolen, or destroyed, disbursing officers of the United States are authorized, after the expiration of six months, and within three years from the date of such check, to issue a duplicate check; and the Treasurer, assistant treasurers, and designated depositaries of the United States are directed to pay such duplicate checks, upon notice and proof of the loss of the original checks, under such regulations in regard to their issue and payment, and upon the execution of such bonds, with sureties, to indemnify the United States, as the Secretary of the Treasury shall prescribe. This section shall not apply to any check exceeding in amount the sum of twenty-five hundred dollars." (Sec. 3646, R. S., Act Feb. 16, 1885.)

NOTE.—A special act of Congress is necessary to enable a disbursing officer to issue a duplicate check in case the amount of the lost check exceeds $2,500.

The following is an example of an act of this kind:

"*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That Captain W. H. Bixby, Engineers United States Army, be, and is hereby, authorized and instructed to issue a duplicate of an original check under such regulations in regard to its issue and payment as have been prescribed by the Secretary of the Treasury for the issue of duplicate checks under the provisions of section thirty-six hundred and forty-six, Revised Statutes of the United States. Said duplicate check to take the place of an original check issued by said W. H. Bixby on September twenty-fifth, eighteen hundred and ninety-three, upon the subtreasury at New York, in favor of Hughes Brothers and Bangs, for the sum of five thousand and eleven dollars and ninety-three cents, and numbered two hundred and fifty-nine thousand and one, being for services in August, eighteen hundred and ninety-three, under their contract with the United States for work at Point Judith, Rhode Island, which check is alleged to have been lost in its transmission through the United States mail."

Approved August 27, 1894.

"In case the disbursing officer or agent by whom such lost, destroyed, or stolen check was issued, is dead, or no longer in the service of the United States, it shall be the duty of the proper accounting officer, under such regulations as the Secretary of the Treasury shall prescribe, to state an account in favor of the owner of such original check for the amount thereof, and to charge such amount to the account of such officer or agent." (Sec. 3647, R. S.)

TREASURY REGULATIONS IN CASE OF OFFICIAL CHECKS LOST, Etc.

"TREASURY DEPARTMENT,
"WASHINGTON, D. C., June 28, 1889.

"In compliance with the requirements of the preceding sections of the Revised Statutes (Sec. 3646, 3647), the following regulations are established: Immediately upon the loss of a check, the owner, to better protect his interest, should, in writing, notify the office or bank on which it was drawn of the fact of such loss, stating the name of the officer or agent by whom it was drawn, describing the check—giving, if possible, its date, number, and amount—and requesting that payment of the same be stopped.

"In order to procure the issue of a duplicate check, the party in interest must furnish the officer or agent who issued the original check with an affidavit giving the name and residence of the applicant in full, describing the check and its indorsement, showing his interest therein, detailing the circumstances attending its loss, and what action, if any, he has taken to stop payment thereon. The affidavit must be made and signed before an officer authorized to administer oaths generally, and he must certify that he administered the oath.

"He must also furnish to the same officer or agent a bond executed on the accompanying form and according to these instructions, which will be furnished to any officer or agent applying therefor. The affidavit and the bond, when executed, are to be indorsed by the officer or agent as having been submitted to him, and as being the proof and security upon which he has acted. After the expiration of six months after the time the original check was issued, the officer or agent will issue a duplicate, which must be an exact transcript of the original, especial care being taken that the number and date corre-

spond with the original. The affidavit, bond, and duplicate check he will, without delay, forward to the Secretary of the Treasury, who, upon their receipt, will advise the office or bank on which the check was drawn that an application for a duplicate is pending, and the bank or office will immediately inform the Secretary whether a request has been made to stop payment of the original, and whether such original has been presented or paid, and if not paid, a caveat will be entered, and payment will thereupon be stopped.

"If the information obtained is satisfactory to the proper accounting officer of the Treasury, and he approves of the issue of the duplicate, and of the accompanying bond, he will certify such approval in writing, on the papers as well as on the duplicate check, and return them to the Secretary of the Treasury.

"Any duplicate check issued in pursuance of these instructions, bearing such certificate and the approval of the Secretary or Assistant Secretary of the Treasury, may, if properly indorsed, be paid by the Treasurer, the Assistant Treasurer, or depositary on whom it is drawn, subject to the same rules and regulations as apply to the payment of original checks; but no duplicate shall be paid if the original shall already have been paid.

"In case of the loss of a check issued by a United States disbursing officer or agent who is dead or no longer in the service of the United States, the affidavit and bond required to be furnished by the owner of said check to an officer or agent in the service of the United States, prior to the issue of a duplicate check, should be forwarded to the Secretary of the Treasury who will refer them to the proper accounting officer for examination and the statement of an account in favor of the owner of said check, as provided for in section 3647.

"Whenever such an account shall have been stated, and an officer or agent charged with the amount of any duplicate check, the final accounting officer will notify the Secretary of the Treasury in order that the amount of the original check, if remaining to the credit of the officer or agent in any United States depositary, may be repaid into the Treasury and carried to his credit and to the credit of the proper appropriation.

"These regulations shall not apply to any check exceeding in amount the sum of $2,500.00.

"W. WINDOM, Secretary."

CIRCULAR INSTRUCTIONS RELATIVE TO PUBLIC MONEYS AND OFFICIAL CHECKS OF UNITED STATES DISBURSING OFFICERS.

"TREASURY DEPARTMENT,
"WASHINGTON, D. C., August 24, 1876.

"(SECTIONS 3620, 5488, R. S.)

Care of Public Funds.—"In accordance with the provisions of the above sections, any public money advanced to disbursing officers of the United States must be deposited immediately to their respective credits, with either the United States Treasurer, some Assistant Treasurer, or designated depositary, other than a national bank depositary, nearest or most convenient, or, by special direction of the Secretary of the Treasury, with a national bank depositary, except—

"1. Any disbursing officer of the War Department, specially authorized by the Secretary of War, when stationed on the extreme frontier or at places far remote from such depositaries, may keep, at his own risk, such moneys as may be intrusted to him for disbursement.

Form of Official Checks.—"2. . . . . Any check drawn by a disbursing officer upon moneys thus deposited must be in favor of the party, by name, to whom the payment is to be made, and payable to 'order' or 'bearer' with these exceptions:

"1. To make payments of individual pensions, checks for which must be made payable to 'order'; 2. To make payments of amounts not exceeding $20; 3. To make payments at a distance from a depositary, and 4. To make payments of fixed salaries due at a certain period; in either of which cases, except the first, any disbursing officer may draw his check in favor of himself or bearer for such amount as may be necessary for such payment, but in the

last named case the check must be drawn not more than two days before the salaries become due.

"Any disbursing officer or agent drawing checks on moneys deposited to his official credit must state on the face or back of each check the object or purpose to which the avails are to be applied, except upon checks issued in payment of individual pensions, the special form of such checks indicating sufficiently the character of the disbursement.

"Such statement may be made in brief form, but must clearly indicate the object of the expenditure, as, for instance, 'pay', 'pay-roll' or 'payment of troops', adding the fort or station, 'purchase of subsistence' or other supplies; 'on contract for construction', mentioning the fortification or other public work for which the payment is made; 'payments under $20', etc.

. . . . . .

"No allowance will be made to any disbursing officer for expenses charged for collecting money on checks.

"In case of the death, resignation, or removal of any disbursing officer, checks previously drawn by him will be paid from the funds to his credit, unless such checks have been drawn more than four months before their presentation, or reasons exist for suspecting fraud."

. . . . . .

"CHAS. F. CONANT, Assistant Secretary."

"(1886. DEPARTMENT No. 109.)

"TREASURY DEPARTMENT, FIRST AUDITOR'S OFFICE,
"WASHINGTON, D. C., August 20, 1886.

Vouchers from Corporations.—"In auditing accounts of disbursing officers, all accounts of corporations paid in cash must be receipted by an officer of such corporation authorized to receipt for money belonging thereto, evidence of which authority must either accompany the voucher or be filed in the Department. Receipts for small sums paid to corporations, such as railroad, telegraph, turnpike, transfer, express, steamboat, hotel, newspaper and ice companies, when it is impracticable to obtain the signature of the proper officer of the corporation, may be signed by the local agent authorized to receive and receipt for money at the places where services were rendered or articles purchased.

"Where an account is paid by draft on the Treasurer or Sub-Treasurer, in the name of the corporation as payee, and such fact stated on the voucher, with the number of the draft, authority for signature will not be required.

"Individual accounts must be receipted by the individual; firm accounts, by a member of the firm, or be paid by draft, as in the case of corporations.

. . . . . .

"C. S. FAIRCHILD, Acting Secretary of the Treasury."

CHAPTER II.

WAR DEPARTMENT, LAWS AND REGULATIONS.

DUTIES.

Secretary of War.—As head of the Department the Secretary of War is in responsible charge to a greater or less degree of all the work of his Department, which includes work devolving upon it from its nature, (as preparation for the general defense), or intrusted to it by the President of the United States or by Congress. (Sec. 216 R. S.) He is assisted in his duties by an Assistant Secretary of War. (Act March 5, 1890.)

It is his duty to prescribe regulations, not inconsistent with the law, for the government of his Department and the conduct of business under it. (Sec. 161 R. S.) The General Regulations for the Army of the United States and the Regulations for the Government of the Corps of Engineers, U. S. Army, promulgated by the Secretary of War in accordance with this statute, have the force of law.

Commanding General.—"The military establishment is under the orders of the General commanding the Army in that which pertains to its discipline and military control. The fiscal arrangements of the Army are conducted by the Secretary of War, through the several staff departments." (A. R. 186.)

Department Bureaus.—The Secretary of War exercises control through the bureaus of the War Department. . . . (A. R. 813.) The particular duties to be assigned to the various bureaus (or departments of the War Department) are in some cases defined by law. In other cases the assignment is left to the discretion of the Secretary of War.

ENGINEER DEPARTMENT.

Personnel.—This Department, including the Engineer bureau, is under the command of the Chief of Engineers, who has his headquarters at the seat of Government. The personnel of the Department includes the Corps of Engineers, and Engineer troops, U. S. Army, and such civilian assistants as are employed from time to time.

Duties—Corps of Engineers.—"The duties of the Corps of Engineers comprise . . . 1. The selection of sites and formation of plans and estimates for military defenses; the construction and repair of fortifications and their accessories of every description; . . . the construction of military roads and bridges; also the execution of river and harbor improvements assigned to it, and such other duties as the President may order. . . . " (A. R. 1683.)

2. The construction and renovation of light-houses. (Sec. 4664 R. S.)

3. Municipal engineering works of Washington, D. C. (Act June 11, 1878.)

4. The care of public buildings and grounds of the District of Columbia. (Sec. 1797 R. S.)

5. By special legislation the construction of the Building for the Library of Congress has been placed in the charge of the present Chief of Engineers, Brig.-General Thos. L. Casey.

Stations.—For carrying out the duties devolving on the Corps, the Chief of Engineers has his office in Washington, D. C., with a small staff of assistants. The other officers of the Corps are stationed throughout the country wherever their presence is required.

River and Harbor Improvements.—For works of River and Harbor Improvement the entire country is divided into districts containing a certain number of localities under improvement. Each district is under the charge of an officer or duly accredited United States agent, who has his office in that city within the district from which he can

best conduct the operations with which he is charged. He is assisted by a body of employees stationed through the district where needed.

Officer in Charge of District.—The District Engineer is held responsible for and superintends the execution of all projects of river and harbor improvement within his district, and to this end, subject to the approval of the Chief of Engineers, he makes contracts and enforces their provisions, carries on works by hired labor, authorizes all purchases and makes all disbursements, in accordance with the Regulations for the Army and for the Corps of Engineers.

Fortifications.—The works of fortification are usually assigned also to the charge of the officer in whose district they are situated, and are carried on in accordance with the same Regulations.

Light-houses.—The Light-house engineers conduct their work under the orders of the Secretary of the Treasury. Their methods will be described in another chapter. (Chap. IV.)

Engineer Commissioner, District of Columbia.—An Engineer Commissioner, who must be an officer of the Corps of Engineers of at least twenty years service, and holding the rank of captain or a higher grade, with three Engineer Officers as assistants, is in charge of all works of municipal engineering in the District of Columbia, which are carried on by the District Government. He works under special laws governing the District, as will be described later. (Chap. VII.)

Congressional Library Building.—The present Chief of Engineers is charged by Congress with the construction of the new Congressional Library Building. He also conducts the operations under special laws, but in the general manner followed by the Corps.

Public Buildings and Grounds, Washington, D. C.—Another officer of the Corps is charged with the care of the public buildings and grounds of Washington, including all buildings occupied exclusively by the War Department and its branches, and excluding the Capitol and its grounds, and buildings occupied by special Departments, such as Post Office, Patent Office, Treasury and the like. To his care are assigned the parks of Washington. The methods he follows are those of the Corps.

QUARTERMASTER'S DEPARTMENT.

Duties.—"Under existing laws, the Quartermaster's Department, under the direction of the Secretary of War, provides the Army with military stores and supplies requisite for its use, such as clothing and equipage, tents, band instruments, tableware and mess furniture, equipments for post bakeries, fuel, forage, stationery, lumber, straw for bedding for men and animals, all materials for camp, and for shelter for troops and stores, furniture for barracks, such as bunks, benches, chairs, tables, lockers, heating and cooking stoves for use in public barracks and quarters, tools for mechanics and laborers in the Quartermaster's Department, furniture, text-books, papers, and equipment for post schools, reading matter for post libraries, wagons, ambulances, carts, saddles, harness, water supply, sewerage, plumbing, illuminating supplies, and heating, for all military posts and buildings.

"The department is also charged with the duty of transporting, by land and water, troops, munitions of war, equipments and all articles of military supplies from the place of purchase to the several armies, garrisons, posts, and recruiting places.

"Under act of Congress amending section 1661, Revised Statutes, for arming and equipping the militia, this department supplies quartermaster's stores, clothing, and equipage to the militia of the several States and Territories, and transports the same to said States and Territories. It also furnishes transportation for ordnance and ordnance stores issued by the United States to the militia of the several States and Territories. It also transports the property for other Executive Departments on requisitions, payments therefor being made by the respective departments to the carriers upon accounts forwarded through the Quartermaster-General's Office for that purpose.

"This department prepares the necessary plans and constructs all buildings at military posts, such as barracks, quarters, storehouses, hospitals, etc., builds wharves, constructs and repairs roads for military purposes, builds all necessary military bridges, provides, by hire

or purchase, grounds for military encampments and buildings; contracts for all horses for cavalry, artillery, and for the Indian scouts, and for such infantry and members of the hospital corps in the field campaigns as may be required to be mounted; pays for all incidental expenses of the military service which are not provided by other corps.

"The care and maintenance of national cemeteries is an additional duty of this department. It also provides suitable headstones to mark the graves of all soldiers, sailors, or marines who served during the late war, including those who have been buried in private cemeteries and other burial places.

"Section 1139, Revised Statutes, makes it the duty of the Quartermaster-General, under the direction of the Secretary of War, to prescribe and enforce a system of accountability for all quartermaster's supplies furnished the Army, its officers, seamen, and marines." (Rep. Quartermaster-General, 1894.)

This volume treats only of those duties of the Quartermaster's Department which pertain to construction and repair work. The business methods described for work of this character are the same as for all work of this Department, and are laid down in the Army Regulations.

Personnel.—The head of the Department is the Quartermaster-General, who, with a small staff of assistants, has his headquarters at Washington. The personnel of the Department comprises a corps of officers permanently commissioned in the Department, a body of officers called Acting Assistant Quartermasters, assigned temporarily from other branches of the Army, and civilian employees.

Stations.—At each of the Military Department Headquarters is a Chief Quartermaster who has supervision over the operations of the Quartermaster's Department in that Military Department. At each military post and at all points where work is being carried on, there is an Assistant Quartermaster or an Acting Assistant Quartermaster in local charge, through and by whom proposals are requested, and contracts, purchases and disbursements are made.

APPROPRIATIONS AND ALLOTMENTS.

Appropriations.—All disbursements made by the War Department must be authorized by acts of Congress. These acts may be [A] general, appropriating a lump sum for all work of a specific character, or [B] may designate the specific works to which the money is to be applied. They may also [C] limit to one fiscal year the time during which the money appropriated may be used, or [D] they may make the appropriation available until expended. Of late years Congress has in certain cases [E] authorized contracts to be entered into for definite sums to complete certain works and has appropriated at the time only the money estimated for one year's operations, leaving the remainder to be appropriated as required at subsequent sessions.

Appropriations Under Engineer Department.—The appropriations for purchase of sites and construction and repair of fortifications are of classes "A" and "D", for river and harbor works in general under "B" and "D", for certain important specified works under "B", "D" and "E", for care and preservation of public buildings and grounds in Washington, D. C., "B" and "C".

Appropriations Under Quartermaster's Department.—In general, appropriations for use of the Department are made under classes "A" and "C"; in particular cases, for the construction of military posts or of certain specified buildings they are in classes "B" and "D".

Allotment of Appropriations.— General appropriations are distributed to the points where work is required by allotments, made by the head of the Department or Bureau to which the expenditure of the appropriation belongs (or, should the law so state, by a specified board or commission,) based on estimates and projects previously submitted by the officers in local charge of the works.

Withdrawal of Funds from Treasury.—An appropriation having become available, the local agent is notified that certain amounts have been allotted or appropriated for the works under his charge. He then submits a detailed project for the expenditure of the funds

available, if one has not been submitted previously, and also an estimate of the amount of money which he will require to carry on the work for a definite period, at present, one month. (Circ. Treas. Dept., July 25, 1892.) The projects having been approved by the head of the Department, on requisition from him through the Secretary of War (Sec. 3673 R. S.), the Secretary of the Treasury deposits at the Sub-treasury or authorized United States depositary most convenient for the disbursing officer, the funds asked for, and notifies the disbursing officer to that effect. The money thus deposited becomes available for use by the disbursing officer on any of the works under his charge, the projects for which have been approved.

BUSINESS METHODS—GENERAL REGULATIONS.

Chapter I gives the general laws and regulations governing operations under the War Department, which are common to all of the Departments; for those relating to application of appropriations, see page 1; to labor, page 1; to protection of persons furnishing materials and labor for use on public works, see page 1; to purchase of land, page 2; to legal holidays, page 2; to purchases, page 2; to contracts, page 3; to transfer of claims, page 4; to payments, page 5; to form of checks, page 8; to payments to corporations, page 9.

Purchase and Use of Land.—"Land shall not be purchased for the United States except under an act of Congress authorizing the purchase; nor shall public money be expended for the erection of armories, arsenals, forts, fortifications, or permanent buildings of any description thereon, until the written opinion of the Attorney-General shall have been obtained announcing the validity of the title thereof in the Government; nor, if the land be selected within any State, until jurisdiction over it shall have been ceded to the United States by the legislature of the State." (A. R. 773.)

Permanent Structures.—Permanent military buildings are constructed in general only by special authority of Congress. (A. R. 774.)

Permanent structures are built and maintained in accordance with plans approved by the Secretary of War, and special authority is required before any contracts are entered into or materials purchased for them. (A. R. 775.)

Title Papers.—Title papers of lands for permanent fortifications are filed in the Engineer bureau; for . . . lands used for barracks, posts, etc., in the office of the Quartermaster-General. (A. R. 776.)

Assistance to Contractors.—"The labor of troops or Government employees, or means of transportation, shall not be used to enable contractors to fulfil contracts, except in cases of manifest necessity, and then only on the written authority of the proper commander, and full deduction shall be made for the services rendered." (A. R. 656.)

Restrictions on Disbursements.—"An officer shall not receive credit for any expense paid for the collection of money on checks. He is not authorized to insure public money or property; nor to settle with heirs, executors, or administrators, except by authority of the proper bureau of the War Department, and upon accounts that have been duly audited and certified by the proper accounting officers of the Treasury." (A. R. 738.)

PURCHASES.

Purchases from, and Contracts with, Officers Forbidden.—No officer concerned in the disbursement of money will be concerned in the purchase or sale of any article intended for or pertaining to the Department to which he belongs. (A. R. 744.)

Supplies shall not be purchased from or contracts made with any other person in the military service. (A. R. 746.)

Methods Prescribed.—"An officer charged with the duty of making a contract, or purchase, is responsible under the laws and regulations for his course of action. . . ." (A. R. 621.)

"Officers required to make contracts or purchases 'will, when practicable, give public notice, . . .' inviting sealed proposals." (A. R. 617.)

"When because of an emergency it is impracticable to give ten days notice for proposals, the officer will invite sealed proposals for the supplies or service required, by advertising, or by posters or circular letters, sent to principal dealers, or by both these methods combined, giving as many days notice as practicable." (A. R. 619.)

Purchases Under Act of 1894.—". . . *Provided further*, That after advertisement all supplies for the use of the various departments and posts of the Army shall be purchased where the same can be purchased the cheapest, quality and cost of transportation considered, except that purchases may be made in open market in the manner common among business men when the aggregate amount required does not exceed two hundred dollars, but every such purchase shall be immediately reported to the Secretary of War." (Act Aug. 6, 1894.)

Open-market Purchases.—* "With reference to cases in which the aggregate amount of supplies required does not exceed two hundred dollars, open purchases should not be resorted to when, without detriment to the service, an immediate consolidation of requisitions that will in the aggregate exceed two hundred dollars can be made, or when the opportunity for such consolidation can reasonably be anticipated.

"The provision of law contained in the Army bill approved Aug. 6, 1894, in reference to open-market purchases of this character was not intended to change the present mode of procuring the regular supplies by public advertisement and contract, as required by R. S. 3709, except in regard to such small supplies as cannot be advantageously procured by inviting competitive bids.

"The regular supplies, the quantity of which required for use during any fiscal year is sufficient to warrant advertisement, must not be purchased in small lots in order to bring the value of each purchase within the amounts fixed by the law cited above. This law is intended to permit the purchase, in open market, of such small supplies as do not come under the head of public-exigency purchases, and the value of which is insufficient to induce reliable dealers to compete for their supply, and which under R. S. 3709 cannot be purchased promptly and at the lowest market rates.

"It is forbidden to secure supplies by open-market purchase which can be as advantageously procured by public advertisement and contract, as prescribed by R. S. 3709. The latter mode of purchase must be continued in all cases where it will not be to the injury of the public interests." (Ext. Letter dated War Deptmt., Nov. 6, 1894.)

*See also p. 18.

ADVERTISING.

Methods of Giving "Public Notice."—"The law does not restrict advertising solely to newspapers. Proposals may be invited through hand-bills, posted in public places, or circular letters; but advertising in newspapers will be resorted to when time permits, and when in the judgment of the disbursing officer the proposed expenditure is sufficiently large to justify it." (A. R. 595.)

"Notices inviting proposals will be issued by the officer who is to make the contract or purchase; in special cases, however, if competent authority direct it, by any other officer. . . ." A. R. 596.)

"No advertisement, notice or proposal for the War Department or any bureau thereof, or any office connected therewith, will be published in any newspaper except in pursuance of written authority of the Secretary of War." (A. R. 597.)

NOTE.—The laws and regulations regarding advertising and printing for the War Department are to be found in a pamphlet published by the War Department entitled "Regulations of the War Department relative to Newspaper Advertising and Job-printing." This also contains a list of the papers which have signified their willingness to accept the regulations and rules of the War Department, and are designated by the Secretary of War as papers in which official advertisements may be placed.

Length of Notice.—As a general rule, thirty days is to intervene between the date of the first publication of the advertisement and the

date for opening the proposals. If necessary, a shorter time may be allowed, limited to ten days except in cases of emergency. (A. R. 602.)

Number of Insertions.—"Ordinarily advertisements will be given six insertions in daily, or four in weekly papers. Those in daily newspapers inviting proposals will, when more than ten days are to intervene between the date of the first publication and the date of opening, be given: first, four consecutive insertions, and subsequently, immediately before the date of opening, two consecutive insertions. Advertisements, in case of emergency, may be given two or more insertions, as time and circumstances permit. . . ." (A. R. 603.)

PROPOSALS AND CONTRACTS.

Powers Granted to Secretary of War.—The Secretary of War is authorized "to prescribe rules and regulations to be observed in the preparation and submission and opening of bids for contracts under the War Department." "And he may require every bid to be accompanied by a written guarantee, signed by one or more responsible persons, to the effect that he or they undertake that the bidder, if his bid be accepted, will, at such time as may be prescribed by the Secretary of War or the officer authorized to make a contract in the premises, give bond, with good and sufficient sureties, to furnish the supplies proposed or to perform the service required.

"If after the acceptance of a bid and a notification thereof to a bidder he fails within the limit prescribed by the Secretary of War or other duly authorized officer to enter into a contract and furnish a bond with good and sufficient security for the proper fulfilement of its terms, the Secretary or other authorized officer shall proceed to contract with some other person to furnish the supplies or perform the service required, and shall forthwith cause the difference between the amount specified by the bidder in default in the proposal and the amount for which he may have contracted with another party to furnish the supplies or perform the service for the whole period of the proposal to be charged up against the bidder and his guarantor or guarantors, and the sum may be immediately recovered by the United States for the use of the War Department in an action of debt against either or all of such persons." (Acts Apl. 10, 1878, and Mar. 3, 1883.)

The requirements of the foregoing acts are more fully set forth in the following regulations:

Proposals.*—The official advertisements direct interested persons to apply to the agent of the United States in local charge, for specifications, general instructions to bidders, and blank forms of proposals. The following regulations govern the preparation and opening of proposals.

The specifications for the materials or the labor required shall be as full as possible. (A. R. 623 and 624.)

"Proposals should be prepared in strict accordance with the requirements of the advertisement or circular of instructions. . . ." (A. R. 626.)

"When no guarantee is required, bidders must, if called upon by the awarding officer, furnish satisfactory evidence before the award is made, of the ability to carry their proposals into effect." (A. R. 632.)

"No bidder will be informed directly or indirectly, of the name of any person intending to bid, or not to bid, or to whom information with respect to proposals has been given." (A. R. 625.)

"When an advertisement calls for proposals to furnish labor or supplies at more than one place, a separate proposal will be made for performance at each place, but all may be submitted in the same envelope." (A. R. 634.)†

"Proposals received prior to the time of opening will be securely kept, so that they cannot be tampered with. The officer whose duty it is to open them will decide when that time has ar-

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* For special instructions of the Engineer Department to bidders, see page 23; of the Quartermaster's Department, see page 26.

† Modified in certain cases of River and Harbor Improvement. (See page 25.)

rived, and no proposal, for that opening, will thereafter be received." (A. R. 635.)

"Proposals will be opened and read aloud at the time and place appointed for the opening. All the bidders have the right to be present, and a record of each proposal shall then and there be made upon an abstract prepared according to paragraph 640." (A. R. 637.)

"Except in rare cases, when the United States may elect to exercise its right to reject proposals, contracts will be awarded to the lowest responsible bona-fide bidder, who, when required, produces a proper article, and whose proposal therefor is not unreasonable. In considering bids on similar lists of articles, the advertisements and circulars should, in the absence of a fixed standard for all the articles bid for, be so worded as to permit the award for the most suitable articles offered for the purpose required, and the bids must be considered item by item." (A. R. 638.)

"Slight failures on the part of a bidder to comply strictly with the terms of the advertisement should not necessarily lead to the rejection of his bid; but the interest of the Government should be fully considered in making the award." (A. R. 639.)

For further instructions regarding proposals, see instructions to bidders, Engineer Department, page 23; or Quartermaster's Department, page 26.

Guarantees to Accompany Proposals.—An officer empowered to make a contract shall require written guarantees, as provided for in the Act of March 3, 1883, whenever in his opinion such a guarantee is necessary. . . . (A. R. 645.)

The fact that a guarantee is required must be made known to bidders, as well as the sum in which the guarantor must justify, and the time allowed for the execution of the contract and bond. (A. R. 646.)

"Where guarantees are required from bidders, no proposal will be considered unless accompanied by a guarantee made in the manner and form as directed in the advertisement or circular of instructions." (A. R. 647.)

For form of guarantee, see pages 185 and 192.

The regulations as to contractor's bonds will appear later.

For further instructions as to guarantees see, for Engineer Department, page 23; for Quartermaster's Department, page 26.

Contracts.—"When ever the Secretary of War invites proposals for any works, or for any material or labor for any works, there shall be separate proposals and separate contracts for each work, and also for each class of material or labor for each work." (Sec. 3717 R. S.) (See also p. 25.)

"Contracts will be made as nearly as practicable according to prescribed forms, departing therefrom only so far as requisite to meet the necessities of the public service. All conditions will be stated therein as fully and clearly as possible. Contracts shall be made in the name of and shall be signed by the chief officer of that branch of the staff of the command to which they pertain." (A. R. 652.)

"Upon receipt of the contract at the proper bureau of the War Department, it will be examined to see that it complies with the laws, regulations and orders. If found correct, the approval of the proper officer will be indorsed thereon. Should any illegality be discovered, it will be submitted to the Secretary of War for his action." (A. R. 653.)

"Contracts will be executed in quintuplicate. . . ." (A. R. 654.)

For form of contract see pages 186, 193 and 194.

"In all contracts for material for any public improvement the Secretary of War shall give preference to American material, and all labor thereon shall be performed within the jurisdiction of the United States." (Act of March 3, 1875.)

Transfers of contracts or interests in contracts are forbidden. (Sec. 3737 R. S.)

Members of Congress are forbidden to have any interest in contracts for public works. (Secs. 3739, 3740, and 3747 R. S.)

Payments on Contracts.—In the case of contracts running through long periods of time, it is the general custom of the United States to

pay on monthly estimates of work done, when the execution of the contract is satisfactory, reserving 10 per cent of the amount due until final payment, as additional security for faithful performance of the contract.

Contractor's Bond.—For form, see p. . To be executed in duplicate. "The amount of the penalty to be entered in the contractor's bond shall not be less than one tenth nor more than the full amount of the total consideration of the contract; it will be fixed in each case by the officer representing the United States." (A. R. 662.)

For form of justification for sureties and guarantors, see p. .

"The sureties must jointly justify in double the amount of the penalty. The affidavit will be taken before any official, or person, authorized by the laws of the United States, State, Territory, or District, to administer oaths." (A. R. 664.)

"Bonds are to be executed by the contractor as principal, and two sufficient and responsible persons as sureties." (See also the general regulations for bonds which follow.) "Each must affix to his signature a formal seal of wax, or other adhesive substance, and each signature must be attested by at least one witness. When practicable, there will be a separate witness to each signature. Sureties must be citizens of the United States." (A. R. 666.)

Surety.—"A firm will not be accepted as surety, nor will a partner be accepted as surety for a copartner, or for a firm of which he is a member. Stockholders of a corporation, who are not officers thereof, may be accepted as sureties for such corporation." (A. R. 667.)

"A guarantor, or the guarantors, to a bidder's guarantee, may be accepted as surety, or sureties, to the bond of the same person as contractor, provided such guarantor or guarantors are able to justify, as required for the bond. Bidders' guarantees and contractors' bonds will be executed in duplicate. . . ." (A. R. 668.)

The following regulations were promulgated in G. O. 52, A. G. O., 1893:

Bonds from Corporations.—"Section 1. When the principal of a bond is a corporation, a copy of its charter or articles of incorporation, authenticated by the Secretary of State or other officer having authority, is required to be attached to the bond. There shall also be attached thereto a copy of the record of the organization of the corporation and of the selection and qualification of the officers executing the bond in its behalf, as well as a copy of the record of the proceedings of the board of directors or other governing body of the corporation showing their authority to execute the same—these copies to be duly certified by the custodian of such records, under the seal of the corporation, to be correct copies."

Corporations as Sureties.—"Section 2. The War Department will accept as surety on bonds any company which is duly incorporated under the laws of the United States, or of any State, and is legally authorized to become such surety; but a foreign company will not be accepted.

"Section 3. Before a corporation will be accepted as surety, there shall be filed with the Secretary of War a copy of its charter or articles of incorporation and of all laws that may be necessary. or which may be required in addition to the charter, to show that it has power to enter into the obligation—these copies to be authenticated by the Secretary of State or other officer having authority; and also a copy of the record of the organization of the corporation and of the selection and qualification of the present officers, as well as a copy of the by-laws or other records authorizing certain officers of the corporation to execute bonds in its behalf—these copies to be duly certified by the custodian of such records, under the seal of the corporation, to be correct copies. There shall also be filed an itemized statement of the financial condition of the company, showing its assets and liabilities, and a statement of the amount of its existing obligations as surety, duly certified under the corporate seal, by the custodian of the records of the corporation, to have been compared by him with the records and found to be correct. These papers are not to be attached to the bond. All papers specified and a statement of the

financial condition of the company shall be furnished as often as the Secretary of War may require; provided, however, that the financial statement shall be furnished semi-annually, without being called for, and the evidence as to the selection and qualification of the officers of the company shall be furnished immediately after their election; and whenever any change shall be made in their authority to execute bonds evidence thereof shall be immediately furnished.

"Section 4. In case of financial embarrassment, failure, or other disqualifying cause on the part of the surety to a bond, the Secretary of War will require the bond to be renewed to his satisfaction, upon notification to the principal of the bond.

"Section 5. The fact that the surety company is actually doing business must be certified to by some United States judge or district attorney, or, in their absence, by some other civil officer of the United States, or by the judge or clerk of a State court of record, with the seal of said State court attached to the certificate."

Non-corporate Guarantors and Sureties.—"Section 6. Justification of non-corporate guarantors and sureties shall be followed by the certificate of a judge or clerk of a United States court, or United States district attorney, or United States commissioner, or judge or clerk of a State court of record, with the seal of said State court attached, that the guarantors or sureties are known to him, and that, to the best of his knowledge and belief, each is pecuniarily worth, over and above all his debts and liabilities, the sum stated in his affidavit of justification. If found necessary, separate certificates may be furnished as to each guarantor or surety.

"Section 7. The principal and surety must sign and seal the bond, the corporate seal of the corporation must be affixed to the bond by the party thereto authorized, who must also affix the name of the corporation to it, followed by his own signature and official designation written after the word 'by'. The names and places of business of the principal and surety must be written in the body of the bond." (Signed by the Acting Secretary of War, May 29, 1893. Published in G. O. 52, A. G. O. 1893.)

A simpler form of contract may be used at the discretion of the disbursing officer, subject to the approval of the chief of his bureau, when the amount involved does not exceed $3,000.00, and the stipulations are to be fully performed within thirty days. (A. R. 670.)

"When purchases are made under sealed proposals, without executing formal written contracts, the officer will give to each successful bidder written notification of the acceptance of his proposal, and file a copy thereof with the proposal. These notifications will expressly state the name of the article, quantity, quality, price, kind of package, and time and place of delivery. . . ."

Then follows a similar provision for services other than personal. (A. R. 671.)

OPEN-MARKET PURCHASES.*

"Supplies may be procured by open purchase, and services [other than personal] may be engaged, in the manner common among business men, in the following cases, viz.:

"1. When the public exigencies require immediate delivery of supplies or performance of services, leaving no time to advertise by newspapers or circulars.

"2. When the aggregate amount of supplies required does not exceed two hundred dollars.

"3. When prices of articles are fixed and uniform, and no competition can be had.

"4. When proposals have been invited and none received.

"5. When proposals are above the market price or otherwise unreasonable.

"Before making an open purchase the purchasing officer will inform himself by inquiry, personal or otherwise, among principal dealers in his locality, concerning prevailing prices." (A. R. 672.)

PAYMENTS.

"No advances of public money shall be made in any case whatever, except such amounts to disbursing officers of the Government

* See also p. 14.

as may be necessary to the fulfilment of the public engagements. . . ." (A. R. 674.)

"Disbursing officers are forbidden to pay any account or indebtedness until it is fully due. . . ." (A. R. 675.)

Rules for the Computation of Time in Payment for Services.—"When applicable, the following rules for the computation of time, in payment for services, will be observed:

"1. For any full calendar month's service, at a stipulated monthly rate of compensation, payment will be made at the stipulated rate, without regard to the number of days in that month.

"2. When service commences on an intermediate day of the month, thirty days will be assumed as the length of the month, whatever be the number of days therein.

"3. When service terminates on an intermediate day of the month, the actual number of days during which service was rendered in that calendar month, will be allowed.

"4. When the service embraces two or more months or parts of months, but one fraction will be made. Thus: from September 21st to November 25th, inclusive, will be calculated September 21st to October 20th, inclusive, one month; from October 21st to November 20th, inclusive, one month; from November 21st to November 25th, inclusive, five days—making the time allowed two months and five days.

"5. When two fractions of months occur and both are less than a whole month, as from August 21st to September 10th, the time will be determined thus: August 21st to 30th, inclusive (ignoring the 31st), ten days; from September 1st to 10th, inclusive, ten days—making the time allowed twenty days.

"6. Service commencing in February will be calculated as though the month contained thirty days, thus: from February 21st to February 28th (or 29th), inclusive, ten days. When the service commences on the 28th day of that month, three days will be allowed; and if on the 29th, two days.

"7. If service commences on the 31st day of any month, payment will not be made for that day.

"8. For commutation of subsistence and for services of persons employed at a per diem rate, payment will be made for the actual number of days.

"9. When services are rendered from one given date to another, the account will state clearly whether both dates are included.

"10. In computing the wages of laborers employed at a per diem allowance, the day on which the service begins and the day on which it ends will be allowed in the computation." (A. R. 742.)

VOUCHERS AND CHECKS.

Vouchers.—All payments for supplies or labor under contracts are made on vouchers, and for personal service on pay-rolls, duly signed.

"Vouchers will ordinarily be made out in duplicate; occasionally, in special cases, in triplicate. The number executed will be distinctly stated on each copy." (A. R. 714.)

NOTE.—The following extract from a letter from the Comptroller, dated Oct. 8,1888, published by order of the Secretary of War in Cir. 12, 1889, office of Chief of Engineers, U. S. A., "for the information and guidance of the officers of the Corps of Engineers and agents of the United States serving under the orders of the Chief of Engineers" would seem to be of general application.

"In pursuance of the provisions of Article 3 of section 273, Revised Statutes, I have to request . . . "That hereafter vouchers in support of partial payments or on which there are retained percentages, be made in *triplicate* instead of in duplicate as heretofore, one copy to be retained by the disbursing officer and two to be forwarded to the accounting officers. . . . "

Circular No. 13, 1889, from the same office, states "Concerning Circular No. 12 from this office, dated August 28, 1889, officers . . . are informed that the Second Comptroller deems it a sufficient compliance with his requirement of October 8, 1888, if the triplicate vouchers referred to be made without receipts and without copies of any sub-vouchers; they should, however, be complete in all other respects and certified to by the proper officers. . . ."

When labor is hired or purchases are made by an agent of the United States who is not a disbursing officer, the accounts for the services or the bills for the materials, duly certified to by the agent, must be sent to the proper disbursing officer for payment, the neces-

sary vouchers being sent with the accounts, or prepared by the disbursing officer after their receipt.

Bills to Accompany Vouchers.—"Every voucher in support of a payment for supplies, or for services other than by the day or month, whether it be made pursuant to a formal written contract, or an accepted bid, or an open-market purchase or agreement, (unless it comes within the excepted cases provided for in paragraph 715½) must have attached to it an original bill furnished by the creditor, dated and signed by him or his authorized representative, giving his place of business or residence, and stating (if for supplies furnished) the date of the purchase, the quantity and price of each article, and the amount or (if for services other than by the day or month) the character of the services, the date or dates on which rendered, and the amount. A voucher so accompanied will be made out in favor of the creditor, giving his address, and may state the account in general terms, with the aggregate amount only extended, and the words 'as per bill hereto attached,' or words of like import added.

. . . . . .

"Where papers relating to two or more vouchers are required to accompany accounts, they must be filed with the first voucher paid, and reference thereto made on the other vouchers.

"A voucher for services by the day or month must state the nature of the service, the inclusive dates of service, the time for which payment is made, the rate of pay, and the amount." (A. R. 715.)

"Where a creditor is unable for any cause to make out his bill, or to have it made out, the disbursing officer must set forth on the voucher all the details of the account as required for the bill by paragraph 715, and must give reasons in full on the voucher why the bill is not furnished.

"Original bills need not be attached to vouchers in the following cases, viz.: where, under a formal written contract, quantities delivered or amounts due are determined by a duly authorized inspector, and his certificate as to the facts is filed with the voucher to which it pertains; where a bill of lading or transportation request accompanies a voucher for transportation services performed under public tariffs; where a voucher is for telegraphic services at rates fixed by the Postmaster-General; where a voucher is for services by the day or month; or where a creditor makes out his bill on a blank form of voucher and certifies to its correctness." (A. R. 715½.)

Half Cent.—"Accounts will be expressed in terms of dollars and cents. When fractions of less than one-half cent occur in the footing of a voucher, they will be disregarded; if the fraction be one-half or greater, it will be reckoned as a cent." (A. R. 718.)

Signature on Receipt.—"When a signature is not written by the hand of the party, it must be witnessed, and by a commissioned officer when practicable." (A. R. 723.)

"Disbursing officers will only make payments to, and take receipts of, the party or parties to whom the money is due from the United States, or to a duly appointed attorney.* When an account is presented by an individual who is not known to the disbursing officer, the latter will require such evidence of identity as will secure the Government, as well as himself, against loss." (A. R. 724.)

"The signature to the receipt and the name of the person or business firm as entered at the head of an account, must be literally alike. When payment is made to an 'attorney,' he will be required to sign the receipt with the name of the principal, adding the words 'by his [or her] attorney in fact,' signing his own name thereafter." (A. R. 725.)

Payments to Corporations.—"Where money is payable by a disbursing officer to a person, firm, or corporation, it may be paid to a duly authorized agent or attorney of such person, firm, or corporation, upon his producing and filing with the disbursing officer, or the accounting officers, a power of attorney, or other properly executed written authority, authorizing him to receive such money and to give a receipt or acquittance therefor; and a voucher, signed by the name of such person, firm, or corporation, by the agent or attorney, will

* For decision of the Comptroller of the Treasury relative to "powers of attorney," see p. 4.

be deemed sufficient. The authority of the agent or attorney must be filed with the voucher for the payment. If subsequent payments be made under the same authority, the disbursing officer will refer, on the vouchers therefor, to the voucher with which the authority is filed." (A. R. 726.)

"Receipts for small sums for occasional service paid to corporations, such as railroads, telegraph, turnpike, express, steamboat, hotel, newspaper, and ice companies, may be signed by the local agent in charge of the business of the company at the place where the service is rendered, or where it begins or terminates, and the certificate of the officer making payment that the person to whom payment was thus made was then the local agent of the company, in charge of its business at the place designated, will be sufficient evidence of the agent's authority to receive and receipt for the money paid." (A. R. 727.)

Receipts in Blank Forbidden.—"All officers are forbidden to give or take receipts in blank for public money or property; in all cases the voucher will be made out in full and the exact amount of money or quantity of property, in words, will be written out in the receipt before it is signed." (A. R. 731.)

Vouchers for Unpaid Accounts Forbidden.—"Disbursing officers will not issue vouchers, which act as due bills against the United States, for unpaid accounts, excepting that a certified statement of personal services and of wages due may be given to a discharged employee not paid at the time of discharge for want of funds." (A. R. 732.)

Means of Payment to be Described—Date of Check on Vouchers sent through Mails.—"When disbursing officers draw checks in payment of accounts on funds placed to their credit, they will note upon the receipt or voucher taken for such payment the number, date, and amount of the check given in payment, and designate the assistant treasurer or depositary upon whom it is drawn; and when an account is paid in part in currency the amount of the same will be stated. . . . When vouchers are sent by mail for signature the date in the receipt will be left blank, and the check in payment will not be drawn until the vouchers are received back properly signed, when the date of the check will be added to the receipt." (A. R. 734.)

Protection of Creditors signing Vouchers before receiving Check.—As shown above, creditors of the United States are required to sign the necessary vouchers in advance of the payment. They are protected by the laws (see p. 6. Sec. 5496, R. S.) and regulations against fraud arising from this prior signature. The voucher cannot be used by the disbursing officer to relieve himself from responsibility for the funds intrusted to him unless he can show that a corresponding check has been delivered to the creditor or has been presented for payment. All payments are to be made by checks, with a few unimportant exceptions. After being cashed, these checks are not returned to the drawer, but are retained by the Treasury Department, and are independent evidence of the truth of the statements made on the vouchers as to payments made.

For the Treasury regulations concerning the payment of checks issued in support of vouchers and the form required, see pp. 6 and 8.

Duplicate Checks.—"Sections 3646 and 3647, R. S., and the act approved February 16, 1885, provide that when an original check not exceeding in amount $2,500.00, is lost or destroyed, the disbursing officer may, after six months and within three years of its date, issue a duplicate of the same, which the Treasury or designated depositary may pay, upon the fulfillment of certain conditions, which the Secretary of the Treasury is authorized to prescribe. In case the disbursing officer who issued the original check is no longer in service, the proper accounting officer of the Treasury, under such regulations as the Secretary of the Treasury will make, shall state an account in favor of the owner of the original check for the amount thereof, and charge the same to the account of the disbursing officer." (A. R. 704.)

In compliance with the requirements contained in the laws

referred to in the preceding paragraph, the Secretary of the Treasury has published certain regulations which are to be found in Treasury Circular dated June 28, 1889. (See p. 7.)

Bond in Case of Duplicate Checks.—The following regulations are published by the War Department to govern the preparation of the required bond:

. . . . . .

"In preparing the bond the following general instructions will be observed:

"1. The Christian names must be written in the body of the bond in full, and signed to the bond.

"2. Each signature must be made in the presence of two persons who must sign their names as witnesses.

"3. The penalty of the bond should be in even dollars, and at least double the amount of the lost check, but in no case less than one hundred dollars.

"4. Either a United States judge, commissioner, district attorney, marshal, assessor, or collector of internal revenue, collector, naval officer, or surveyor of the customs, assistant treasurer or designated depositary of the United States, president or cashier of a national bank depositary of the United States, under his proper official designation and seal, or a clerk of a court of record, under the seal of the court, or a commissioned officer of the Army or Navy of the United States, must certify that the sureties are sufficient to pay the penalty of the bond.

"5. A seal of wax or wafer must be attached to each signature.

"6. The residence and post-office address (giving number and street where the residence is so designated) of the principal and of each surety and witness must be given." (A. R. 705.)

In case the check lost be for a sum exceeding the limit laid down in Sec. 3646 R. S., a special act of Congress is required before a new check can be issued. For example see p. 7.

LAWS AND SPECIAL REGULATIONS FOR WORK UNDER ENGINEER DEPARTMENT.

River and Harbor Works.—". . . It shall be the duty of the Secretary of War to apply the money herein and hereafter appropriated for improvements of rivers and harbors, other than surveys, estimates and gaugings, in carrying on the various works, by contract or otherwise, as may be most economical and advantageous to the Government.

"Where said works are done by contract, such contract shall be made after sufficient public advertisement for proposals, in such manner and form as the Secretary of War shall prescribe; and such contracts shall be made with the lowest responsible bidders, accompanied by such securities as the Secretary of War shall require, conditioned for the faithful prosecution and completion of the work according to such contract." (Sec. 3, Act Aug. 11, 1888.)

Land and Materials for River and Harbor Works.—"*Be it enacted, etc.*, That the Secretary of War may cause proceedings to be instituted, in the name of the United States, in any court having jurisdiction of such proceedings, for the acquirement by condemnation of any land, right of way, or material needed to enable him to maintain, operate or prosecute works for the improvement of rivers and harbors for which provision has been made by law; such proceedings to be prosecuted in accordance with the laws relating to suits for the condemnation of property of the States wherein the proceedings may be instituted:

"*Provided, however*, That when the owner of such land, right of way, or material shall fix a price for the same, which in the opinion of the Secretary of War, shall be reasonable, he may purchase the same at such price without further delay;

"*And provided further*, That the Secretary of War is hereby authorized to accept donations of lands or materials required for the maintenance or prosecution of such works." (Act Apl. 24, 1888. See also p. 2, Act Aug. 1, 1888.)

Land for Fortifications.—". . . Hereafter the Secretary of

War may cause proceedings to be instituted, in the name of the United States, in any court having jurisdiction of such proceedings, for the acquirement, by condemnation, of any land, or right pertaining thereto, needed for the site, location, construction, or prosecution of works for fortifications and coast defenses, such proceedings". . . (etc., precisely as in Act of Apl. 24, 1888, above).

"*Provided*, That when the owner of such land or rights pertaining thereto shall fix a price for the same, which, in the opinion of the Secretary of War, shall be reasonable, he may purchase the same at such price without further delay:

Provided further, That the Secretary of War is hereby authorized to accept on behalf of the United States donations of lands or rights pertaining thereto required for the above-mentioned purposes:

And provided further, That nothing herein contained shall be construed to authorize an expenditure, or to involve the Government in any contract or contracts for the future payment of money, in excess of the sums appropriated therefor. . . . (Act Aug. 18, 1890.)

Appropriations for Fortifications.—The act approved September 22, 1888, amended by the act of February 24, 1891, making appropriations for fortifications, etc., provides that the appropriations therein provided for shall be available until expended and shall be expended under the direct supervision of a board therein constituted, to be known as the Board of Ordnance and Fortifications, said board to be under the direction of the Secretary of War; and that, subject to the regulations provided by the Board, the expenditure is to be made by the several bureaus of the War Department having jurisdiction of the same under existing law.

Materials for Fortification Work.—The act approved August 1, 1894, on the same subject, provides that "all material purchased under its provisions shall be of American manufacture, except where in the judgment of the Secretary of War it is to the manifest interest of the United States, to make purchases in limited quantities abroad, which material shall be admitted free of duty."

PROPOSALS.

General Instructions for Bidders.—"1. The attention of bidders is especially invited to the acts of Congress approved February 26, 1885, and February 23, 1887, as printed in Vol. 23, page 332, and vol. 24, page 414, United States Statutes at Large, which prohibit the importation of foreigners and aliens, under contract or agreement, to perform labor in the United States or Territories or the District of Columbia.

"2. Preference will be given to articles or materials of domestic production, conditions of quality and price being equal, including in the price of foreign articles the duty thereon.

"3. Maps of the localities may be seen at this (the advertising) office. Bidders, or their authorized agents, are expected to visit the place and to make their own estimates of the facilities and difficulties attending the execution of the work, including the uncertainty of weather and all other contingencies.

"4. No proposal will be considered unless accompanied by a guarantee in manner and form as directed in these instructions.

"5. All bids and guarantees must be made in duplicate,* upon printed forms to be obtained at this (the advertising) office.

"6. The guaranty attached to each copy of the bid must be signed by two responsible guarantors, to be certified as good and sufficient guarantors by a Judge of United States Court, United States District Attorney, Collector of Customs, or any other officer under the United States Government.

"7. A firm will not be accepted as surety, nor will a partner be accepted as surety for a copartner or for a firm of which he is a member. An officer of a corporation will not be accepted as surety for such corporation. Sureties must be citizens of the United States.

"8. Each signature in proposals, guarantees, contracts, and bonds shall have affixed to them seals of wax, wafer or other adhesive substance, and should be written out in full, and the signatures

* If officers prefer, they may require proposals to be submitted in triplicate.

to the guarantees, contracts, and bonds should be attested by at least one witness, and, when practicable, by a separate witness to each signature.

"9. Each guarantor will justify in the sum of . The liability of the guarantors and bidder is determined by the Act of March 3, 1883, 22 Statutes, 487, Chap. 120, and is expressed in the guarantee attached to the bid.

"10. When firms bid the individual names of members should be written out, and should be signed in full, giving the Christian names; but the signers may, if they choose, describe themselves in addition as doing business under a given name and style as a firm.

"11. The place of residence of every bidder, and post-office address, with county and State, must be given after his signature.

"12. All prices must be written as well as expressed in figures.

"13. One copy each of the advertisement, the instructions for bidders, and the specifications, all of which can be obtained at this (the advertising) office on application by mail or in person, must be securely attached to each copy of the proposal and be considered as comprising a part of it.

"14. Proposals must be prepared without assistance from any person employed in or belonging to the military service of the United States or employed under this office.

"15. No bidder will be informed, directly or indirectly, of the name of any person intending to bid or not to bid, or to whom information in respect to proposals may have been given.

"16. Any one signing the proposal as the agent of another or others, must file with it legal evidence of his authority to do so.

"17. All blank spaces in the proposal and bond must be filled in, and no change shall be made in the phraseology of the proposal, or additions to the items mentioned therein. Any conditions, limitations, or provisos attached to proposals will be liable to render them informal, and cause their rejection.

"18. Alterations by erasure or interlineation must be explained or noted in the proposal over the signature of the bidder.

"19. If a bidder wishes to withdraw his proposal, he may do so before the time fixed for the opening, without prejudice to himself, by communicating his purpose in writing to the officer who holds it, and, when reached, it shall be handed to him or his authorized agent unread.

"20. Reasonable grounds for supposing that any bidder is interested in more than one bid for the same item will cause the rejection of all bids in which he is interested.

"21. No bids received after the time set for opening of proposals will be considered.

"22. The proposals and guarantees must be placed in a sealed envelope marked Proposals for , and inclosed in another sealed envelope addressed to . The outer envelope must be so indorsed as to indicate, before being opened, the particular work for which the bid is made.

"23. The United States reserves the right to reject any and all bids, and to waive any informality in the bids received; also to disregard the bid of any failing bidder or contractor known as such to the Engineer Department.

"24. The bidder to whom award is made will be required to enter into written contract with the United States, with good and approved security, in an amount of , within ten (10) days after being notified of the acceptance of his proposal.

"25. The contract which the bidder and guarantors promise to enter into shall be, in its general provisions, in the form adopted and in use by the Engineer Department of the Army, blank forms of which can be inspected at this (the advertising) office and will be furnished, if desired, to parties proposing to put in bids. Parties making bids are to be understood as accepting the terms and conditions contained in such form of contract.

"26. The sureties are to make and subscribe affidavits of justification on the back of the bond to the contract, and they must jointly justify in double the amount of the penalty.

"27. Bidders are invited to be present at the opening of the bids.

"28. A copy of this advertisement, specifications, and instructions will be attached to the contract and form a part of it.

"29. The contractor should, within ten days from the award of the contract, furnish the office with the post-office address to which communications should be sent.

"30. Transfers of contracts, or of interests in contracts, are prohibited by law.

"31. The contractor will not be allowed to take advantage of any error or omission in these specifications, as full instructions will always be given should such error or omission be discovered.

"32. The decision of the Engineer Officer in charge as to quality and quantity shall be final.

"33. It is understood and agreed that the quantities given are approximate only, and it must be understood that no claim shall be made against the United States on account of any excess or deficiency, absolute or relative, in the same. Bidders are expected to examine the drawings, and are invited to make the estimate of quantities for themselves.

"34. Payments will be made monthly. A percentage of ten (10) per centum will be retained from each payment until the completion of the contract.

"35. Should the time for the completion of the contract be extended, all expenses for inspection and superintendence during the period of the extension, the same to be determined by the Engineer Officer in charge, shall be deducted from payments due or to become due to the contractor; *Provided, however*, That if the party of the first part shall, in the exercise of his discretion, because of freshets, ice, or other force or violence of the elements, allow the contractor additional time, in writing, as provided for in the form of contract, there shall be no deduction for the expenses for inspection and superintendence for such additional time so allowed; *Provided further*, That nothing in these specifications shall affect the power of the party of the first part to annul the contract as provided for in the form of contract adopted and in use by the Engineer Department of the Army." (Official Instructions to Bidders, Engr. Dept.)

CONTRACTS.

Two or More Works in Same Contract.—"Sec. 2. That nothing contained in section thirty-seven hundred and seventeen of the Revised Statutes of the United States, nor in section three of the river and harbor act of August eleventh, eighteen hundred and eighty-eight, shall be so construed as to prohibit or prevent the cumulation of two or more works of river and harbor improvement in the same proposal and contract, where such works are situated in the same region and of the same kind or character. . . ." (Act Sept. 19, 1890.)

No bid for works or supplies under a formal written contract will be accepted or rejected in advance of the approval of the Chief of Engineers. (Par. 68, E. R.)

Extensions of contracts are not to be made except with the approval of the Chief of Engineers. (Par. 71, E. R.)

Payment of expenses due to extensions of contracts must not be demanded of or received from contractors by Engineer Officers or agents, but deduction to cover the amounts must be made on the vouchers from sums due the contractors. (Par. 71a, E. R.)

LAWS AND REGULATIONS FOR WORK UNDER QUARTERMASTER'S DEPARTMENT.

The Quartermaster's Department of the Army in obtaining supplies for the military service shall state in all advertisements for proposals that a preference shall be given to articles of domestic production and manufacture, and to the extent that these articles are needed for the public service on the Pacific coast, to articles produced there. (Sec. 3716 R. S.) (See also p. 14, Ext. from Act Aug. 6, 1894.)

Vouchers.—"Where a purchase under an accepted bid after public notice is made in the Quartermaster's . . . Department, the voucher besides being subject to the foregoing requirements (see

715 A. R., page 20), will be accompanied by a copy of the public notice, the accepted bid, and a copy of the letter accepting the bid, and must contain a certificate that the award was made to the lowest responsible bidder for the best and most suitable articles, and that the needs of the service required the purchase to be made in the manner indicated in the public notice. . . ." (715 A. R.)

PROPOSALS.

General Instructions to Bidders.—"Proposals should be prepared in strict accordance with the requirements made known in the advertisement, or circular of instructions to bidders; and copies of such advertisements, circular, or letter should be attached to the proposal and form part of it, and plans or specifications with which the bidder may have been furnished be referred to in the proposal.

"Numbers and prices should be written out in words as well as expressed in figures; but when a great variety of articles is required, as in case of stationery, hardware, etc., quantities and prices may, if the amounts involved are inconsiderable and the forms of proposals so indicate, be expressed in figures only.

"Specifications need not be written out in the body of a proposal. Their attachment to the proposal or the declaration that they form part of it will be sufficient.

"Alterations by erasures or interlineations should be explained or noted in the proposal over the signature of the bidder.

"Proposals are to be prepared without assistance from any person belonging to, or employed in, the military service of the United States. They should be made in duplicate (or triplicate, as may be required), upon the forms and in the manner designated in the advertisement.

"Proposals should be signed by the bidder submitting them with his usual signature in full.

"When a firm is a bidder, the member of the firm or agent who signs the firm-name to the proposal should state, in addition, the names of all the individuals composing the firm.

"Any one signing a proposal as the agent of another or of others must file with it legal evidence of his authority to do so.

"The place of residence of every bidder, with post-office address, county and State, District or Territory, should be given after his signature.

"All proposals should be inclosed in suitable envelopes, securely sealed, indorsed, and addressed as required by the advertisement, and be delivered to or received by the officer to whom addressed before the time appointed for the opening; and no responsibility shall attach to that officer for the premature opening of any proposal not so indorsed as to show that it is a proposal, and the particular purpose for which it is made.

"When an advertisement calls for proposals to deliver supplies or render services at more than one place, a separate proposal should be made for each place, but all may be submitted in the same envelope.

"The officer whose duty it is to open proposals will decide when the time fixed upon for the opening has arrived, and no proposal for that opening will thereafter be received as formal.

"If a bidder wishes to withdraw his proposal he may do so before the time fixed for the opening, without prejudice to himself, by communicating his purpose, in writing, to the officer who holds it; and when his proposal is reached it shall be handed to him, or his authorized agent, unread.

"Transfers of contracts, or of interests in contracts, are prohibited by law." (Official Instructions to Bidders, Q. M. Dept.)

Guarantees and Bonds.—"When no guarantee is required, bidders must, if called upon by the awarding officer, furnish satisfactory evidence, before the award is made, of their ability to furnish the supplies or perform the work for which they bid.

"Written guarantees, signed by two responsible persons, to accompany proposals pursuant to the Act of March 3, 1883, shall be required whenever, in the opinion of the officer authorized to make contracts under the War Department, such guarantees are necessary to protect the interests of the Government.

"In all cases where guarantees are required from bidders, no proposal will be considered unless accompanied by a guarantee made according to the form prescribed.

"When such guarantee is required, the fact will be stated either in the advertisement or in the printed circular giving instructions to bidders, and in the same will also be stated the sum in which the guarantors must justify, and the period that will be allowed after the date of award for filing the contract and bond.

"A guarantor or the guarantors to a *bidder's* guarantee may be accepted as surety or sureties to the bond of the *same person* (if his bid be accepted) as *contractor*, provided such guarantor or guarantors are able duly to justify as required for the bond.

"Bidders' guarantees and contractors' bonds are to be executed in duplicate.

"Contractors' bonds are to be executed by the contractor as principal, and two sufficient and responsible persons as sureties.

"Each obligor and surety affixes to his signature a formal seal of wax or other adhesive substance.

"Each signature of obligors and sureties is attested by at least one witness; when practicable, by a separate witness to each signature.

"The sureties are to make and subscribe affidavits of justification on the back of the bond, the sum in which they jointly justify to be double the amount of the penalty; the affidavit to be taken before any official or person authorized by the laws of the United States, State, Territory, or District to administer oaths.

"The justification shall, if practicable, be followed by the certificate of a judge of a United States court or United States district attorney, or, in their absence, by some other civil official of the United States, who shall certify that the sureties are known to him, and that, to the best of his knowledge and belief, each is pecuniarily worth, over and above all his debts and liabilities, the sum stated in his affidavit of justification. But, if necessary or more convenient, separate certificates may be furnished as to each surety.

"A firm will not be accepted as a surety, nor will a partner be accepted as surety for a copartner or for a firm of which he is a member. (See Revised Statutes, Sec. 3722.)

"An officer of a corporation will not be accepted as surety for such corporation." (Official Instructions Q. M. Dept.)

CHAPTER III.

WAR DEPARTMENT PUBLIC WORKS.

WORKS UNDER ENGINEER DEPARTMENT.

Fortifications.—At present, construction and repair work on fortifications is carried on by hired labor, with materials bought by contract after advertisement in the usual manner. The works now in process of construction consist of heavy walls of concrete masonry, with one or more abutting arched chambers of masonry, masked by a parapet of earth and sand. Under cover of the parapet are placed cut-stone gun-platforms, resting on concrete foundations. Heavy irons are bolted to the platforms to receive and secure the carriages. The materials of the concrete are proportioned so as to insure tensile strength as well as hardness. The concrete is laid up in place, smooth faces being given by the use of planed and matched boxing and by placing finer-grained concrete next to the boxing, course by course as the work progresses. Where the work is to be monolithic, concrete which has set is covered with a coat of mortar before a new course is added. Top surfaces are finished by a coat of mortar well rubbed in while the concrete is green. In some cases, after the concrete has set, exposed surfaces are waterproofed, by coating with a solution of paraffin in mineral oil, laid on hot and heated in. To give increased strength to the arches, they are at times built with the rammed layers perpendicular to the lines of pressure. This is accomplished by carrying up a top boxing as the arch is built and ramming the concrete in layers having the required inclination.

When the subsoil is wet and yielding the masonry is placed on a pile-and-grillage base.

Concrete Work near New York, 1893.—The cost of concrete work in one of the fortifications near New York in 1893, including only the cost of materials and labor, was as follows:

Cost of Material.

	Cement per bbl.	Broken Stone per cu. yd.	Sand per cu. yd.
Delivered alongside dock	$0.961	$1.386	.....
Unloading into cars	.026	.147	.....
Hauling to yard or shed	.007	.038	.....
Storing in yard or shed	.017	.086	.....
Hauling sand	.....	.....	$0.130
Cost of material delivered at works	$1.011	$1.657	$0.130

Cost of Material and Manufacture of one Cubic Yard of Concrete.

Composition: 1 Rosendale cement, 2 sand, 5 broken stone.

MATERIAL.		
Broken stone, 0.92 cu. yd	$1.524	
Cement, 1.43 bbls	1.445	
Sand, 0.37 cu. yd	0.048	
		$3.017
MANUFACTURE AND DEPOSIT.		
Charging and running mixer	$0.352	
Delivering under derrick	.100	
Hoisting	.176	
Placing and tamping	.317	
Making and setting up forms	.224	
Lumber and nails	.052	
		$1.221
Total cost per cubic yard		$4.238

One charge of the cubical box-mixer, machine mixed and deposited by derrick, makes 1.05 cubic yards of masonry.

The greater part of this material was placed in a wall over 2200 feet long, 15 feet high, 7 feet thick at bottom and 3 feet thick at top, necessitating a long haul, frequent shifting of derricks and forms, and depositing in a contracted space.

Concrete Work and Plant, 1894.—In another work at the main entrance to New York Harbor, during 1893 and 1894, an emplacement for a 10″ gun on a disappearing carriage, its two adjacent magazines, and two casemates for rapid-fire guns were under construction. The plant in use was as follows: 1 cable engine; 1 stationary engine; 2 hoisting-engines; 1 concrete-mixer; 5 derricks; 7 rotary dump-cars; 6 flat cars; 3 concrete cars; 4 iron coal-tubs; 1 wharf; 1 cable tramway partly on trestle; stone and sand bins and cement shed. The cost of this plant and of its installation was as follows:

Wharf, sand and stone bins, cement shed, and grading for track	$9,526.01
Engines, boiler, concrete-mixer, dump-cars, and coal-tubs	6,544.78
Setting up engines and mixer and erecting engine-houses	479.64
Wire cables, ropes, etc., for derricks	1,005.37
Materials and labor for permanent water-supply	825.58
Material and labor for carrier rollers and sheaves on trestle	161.87
Superintendence and office work	480.00
Total	$19,023.25

Cost of Excavation.

10,867 cu. yds. of material excavated, hoisted, and placed in embankment at $0.573055 per cu. yd., including labor and coal, water, oil, waste, etc	$6,227.39
Moving, setting up, and rigging derricks	355.38
Building and moving tracks	68.13
Moving engine	6.03
Operating expenses, material for, and care and maintenance of, plant.	739.21
Repairs to buildings	39.29
260 yds. of earth filling at $0.292855 per cu. yd	76.14
Time allowed employees for legal holidays	173.17
Superintendence, office expenses, and watchman	2,030.32
Total	$9,715.06
Total cu. yds. excavated	10,867
Total cost per cu. yd	$0.894

The material was hard, compact clay, with occasional bowlders.

CONCRETE MASONRY.

Cost of Materials.

	Cement (per bbl.).	Small Stone (per cu. yd.).	Large Stone (per ton).	Sand (per cu. yd.)
On boat alongside wharf	$0.874	$1.134	$0.5206	$0.445
Unloading into cars	.0211	.1225	.1492	.1045
Hauling to yard or shed	.0076	.024	.0494	.0267
Storing in yard or shed	.0138	.0273	.1139	.0271
Placing large stone in wall	....	.....	.2671	... ..
Total cost delivered at work,	$0.9165	$1.3078	$1.1002	$0.0033

Cost of one Cubic Yard of Concrete.

MATERIAL.		
Broken stone, 0.92 cu. yds	$1.2031	
Cement, 1.43 bbls	1.3106	
Sand, 0.37 cu. yds	.2232	
		$2.7370
MANUFACTURE AND DEPOSIT.		
Charging and running mixer	$0.2282	
Delivering under derricks	.0489	
Hoisting	.0548	
Placing and tamping	.2354	
Making and setting up forms	.1404	
Lumber and nails	.0606	
Coal, water, oil, and waste	.0495	
		$0.8179
Cost of one cubic yard of concrete		$3.5549

The total cost of the masonry, including time allowed employees for legal holidays ($250.57), superintendence, care and maintenance of plant, operating expenses, steel beams for ceilings of magazines ($434.30), etc., was, for 10,362.4 cubic yards, $43,170.14, or $4.166 per cubic yard. This does not include the cost of the plant.

The average daily number of employees of each class for the nine months worked was:

Assistant engineer	1.0	Monthly laborers	0.5
Draughtsman	0.4	Carpenters	3.1
Recorder	1.0	Blacksmith	1.0
Master laborer	2.1	Rigger	1.0
Engineers	2.3	Stone-masons	2.4
Firemen	2.2	Team	0.07
Night-watchman	1.0	Laborers (day)	36.3

Concrete Work and Plant, 1893–4.—At one of the East River defenses of New York Harbor the materials, bought by contract, are delivered at the wharf on barges. They are then transferred to cars and hauled by a mule 350 feet to the foot of an incline 400 feet long and with 48 feet rise, up which the cars are drawn by a wire cable moved by a stationary hoisting-engine at the head of the incline. A small locomotive takes the cars from there to the site of the work, a distance of 550 feet. When the material is to be stored away from the track, the body of the car, which is removable, is used as a skip, and is hoisted with its load and swung to the desired place by a steam-hoist derrick having a reach of 40 feet.

The proportions used for the concrete are: Rosendale cement 1, sand 2, and broken stone 4. The sand and cement, with the proper proportion of water, are mixed by hand and taken in barrows to the mixer, into the hopper of which the mortar and wet stone are dropped in the proportion named. These, thoroughly mixed, fall from the mixer into barrows or skips, as the case may be, and are wheeled or swung by the derrick to the point of deposit. The ramming is done by hand, with 18-pound rammers.

Large stones are embedded in the concrete and form about one fifth of the total rammed volume.

Plant.—1 stationary 10-H.P. hoisting-engine with derrick on wharf; 1 mule; 14 tram-cars; 1 40-H.P. Lidgerwood stationary hoisting-engine, with large drum, at top of incline; 1 locomotive; 1 concrete-mixer, driven by a 10-H.P. engine; 2 derricks at the work, with steam hoisting-engines—one 17-H.P. and one 16-H.P.

Improvised Locomotive.—The locomotive was improvised at the work from the designs of the officer in charge (Lieut.-Col. King) by taking a 15-H.P. portable Lidgerwood, reversing double-cylinder, hoisting-engine, cutting the frame, and turning the cylinders so as to bring them vertically over the shaft, and gearing the shaft to one pair of the wheels of a flat car on which was placed the boiler and engine. This locomotive handles two loaded cars easily on the grades and curves.

Concrete-mixer.—The concrete-mixer was also made on the work from the designs of the commanding officer. It is simple and effective. The mixer is as follows: The body of the mixer is a hollow cylinder, 10′ long, 41″ external diameter, made of 3″ spruce plank, in staves $3\frac{1}{2}$″ wide. It is lined with $\frac{1}{32}$″ sheet iron. Projecting $4\frac{1}{2}$″ from the interior surface are four rows of teeth, 12 in a row, equally spaced, of $\frac{7}{8}$″ round iron. Each row has a uniform twist through 90 degrees for the length of the cylinder. The cylinder is inclined, having a drop of 16″ in its length. The upper end is partly closed by a ring of 3″ spruce plank, with an inner diameter of 22″. About 12″ from each end, the cylinder is banded with square iron, 1″ thick and 2″ face. These bands also form the bearings and rest each in two grooved sheaves, each sheave 15″ in diameter and $3\frac{3}{4}$″ face, with a groove $2\frac{1}{2}$″ wide and $\frac{3}{4}$″ deep, set in vertical planes below the cylinder, on each side of the axis and nearly at right angles to it. 6′ 5″ from the lower end, the cylinder is banded with a wooden ring 7″ thick, made of staves 10″ long. This ring forms the driver, on which works the band from the engine. 6″ above the upper end of the cylinder is a platform, with an inclined hopper extending into and through the ring at the upper end of the cylinder. A hopper at the lower end receives the mixed concrete materials.

The cylinder was turned at the rate of 20 to 25 revolutions per minute. To insure mixing, the mortar had to be dropped into the hopper first and the stone immediately afterwards. The capacity of the mixer is about 30 cu. yds. per hour.

Average Cost of Materials used on Gun-emplacements.

Large stone (dock stone)	$0.705 per cubic yard.
Small stone (2″ broken trap and granite)	1.23 " " "
Sand (bank sand)	0.37 " " "
Cement (Rosendale), net cost	0.75 per barrel of 300 lbs.

The above prices are for materials on board of scows or barges alongside the wharf.

The cost of concrete in place during the year 1893 was about $5.54 per cubic yard.

Filling and Excavation.—Sand is placed in layers and is settled by water. Earth is placed in parapets in layers, similar to the process followed in levee embankments. In 1893 the cost of excavation in sand near New York was $0.25 per cubic yard, for sand filling $0.22 per cubic yard. Near San Francisco, for similar work during the same year, the cost of excavation (earth) was $0.43, of sand filling $0.328, per cubic yard, and of earth filling $0.33 per cubic yard.

Cost of Concrete Work near San Francisco, 1893.—The cost of the concrete in one of the fortifications of San Francisco Harbor in 1893, including only the cost of material and labor, was $4.52 per cubic yard. The proportions were 1 Portland cement, 3 sand, and 8 rock. The rock was broken at the work. Large clean gravel was sometimes used and counted as rock.

Cost of Material delivered at Work.

Rock	per. cubic yard.	$1.73
Gravel	" " "	1.30
Sand	" " "	0.97 / 0.66
Cement	per barrel.	2.21

Average Composition of one Cubic Yard of Concrete.

	Pounds.	Cubic feet.	Barrels.
Rock	2,251.6	22.2	
Gravel	431.6	4.3	
Sand	1,014.0	11.3	
Cement	293.5	3.3	0.73

Plant.—The following plant was used at this work for mixing concrete: one 50-H.P. boiler, one 35-H.P. Westinghouse Junior engine, one Gates No. 3 rock crusher, one Ransome & Smith No. 3 concrete-mixer, and one Stearn's bucket-elevator. The materials were dumped into hoppers feeding to the mixer, which automatically combined them in proper proportions, mixed them in a revolving churn and delivered them to the foot of the elevator, which raised them 32 feet to a hopper over the cars on a tramway above the top of the masonry.

Gun-platforms.—These are constructed by excavating the site to the required depths, building a substructure of concrete in which the holding-down bolts for the stone superstructure and for the platform irons are accurately set, and completing by a capping of cut granite and the necessary irons. The stone-work is usually of granite cut accurately to given dimensions, set with the utmost care with close joints and bolted together. The bolts are fastened in place with lead or sulphur.

In 1893 the platforms for one of the mortar-batteries near New York were constructed as follows. The platforms are wells lined with concrete and granite masonry. The thickness of the concrete on the bottom is 3′ 10″. The battery stands on coarse sand in which the ground-water is found at the level of 4′ to 4.5′ above the plane of mean low water of the sea, which is the datum-plane for the work. The platforms are built in groups of four within an epaulment provided with a heavy concrete retaining or "breast-height" wall around the pits, with its base at reference (5). To construct the platforms it was necessary to excavate an area 40′ × 40′ to reference (2.2) (2.8′ below the base of the adjacent retaining-wall and about 2.3′ below the level of the ground-water). This was successfully and cheaply accomplished by the following method, devised by the Assistant Engineer, Mr. J. H. Casey.

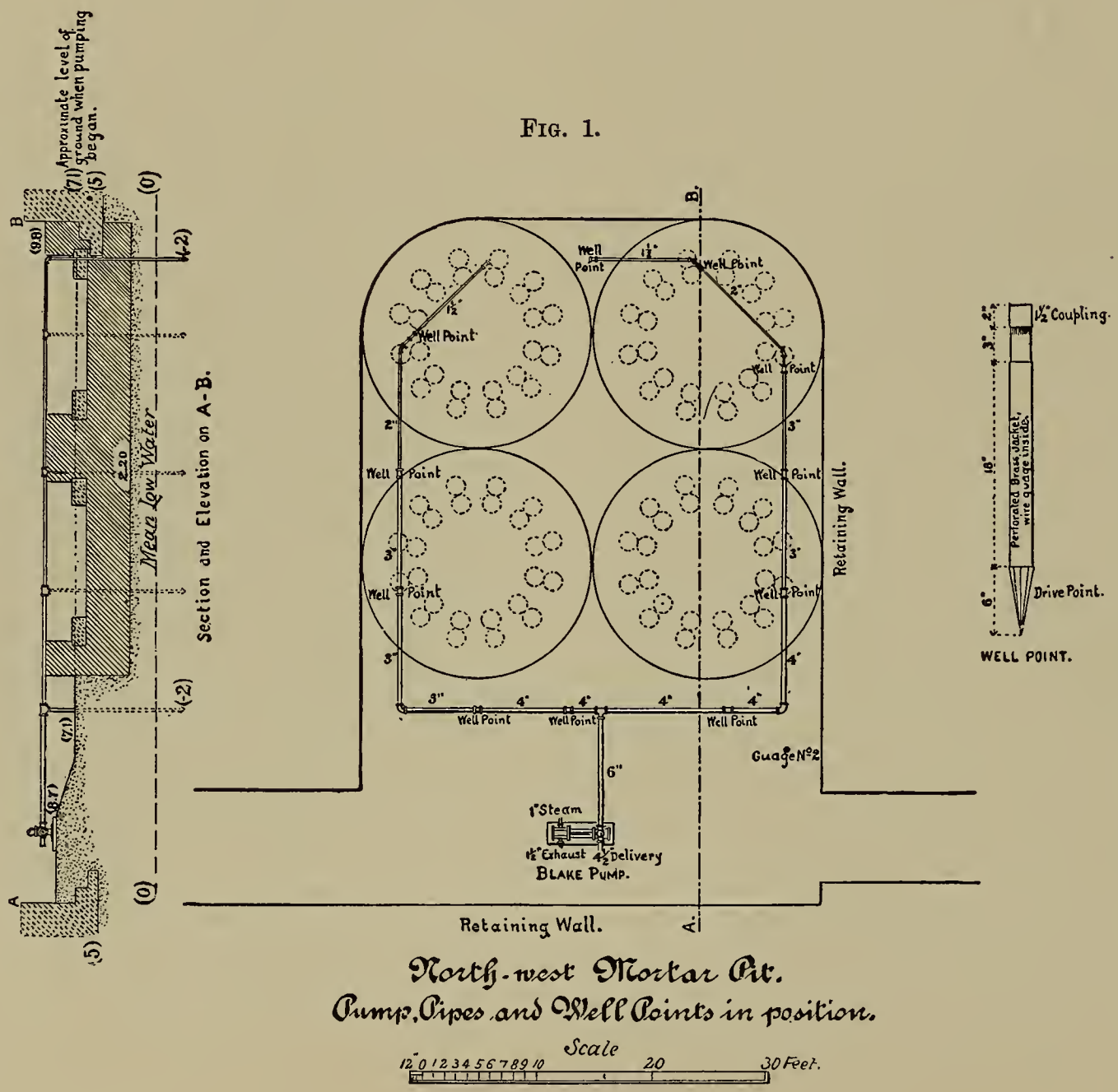
Excavation in Quicksand without Coffer-dam.—Twelve $1\frac{1}{2}$″ well points were driven (see Fig. 1) to the depth of 2′ below the plane of mean low water, reference (−2), at equal intervals around and two feet within the boundary of the area to be excavated. At their tops the points were connected together and to a pump by a line of pipe, 5″ at the pump, diminishing to $1\frac{1}{2}$″ at the extremities. The pump was a Blake tank-pump, having a 12″ stroke, 8″ water-cylinder, and 5″ suction. Running at a speed of 100 strokes per minute, it had a capacity of about 260 gallons per minute. To determine the level of

the ground-water, two pipe-gauges were set close to the area to be excavated, and one 75′ away and one 120′ away (these last were on opposite sides of the work). The gauges were provided with graduated float-rods, from which the readings were taken.

The pump was started at 10 P.M. August 9, and ran continuously. At 8 A.M. August 10 the level of the ground-water was found to be at reference (1.45), and work on the foundations was started. The sand was free from water, but damp enough to stand vertical around the edges of the excavation. At 2.40 P.M. August 11 the concrete had been built to a height above the level of the ground-water and the pump was stopped.

The ground-water at the excavation reached about its lowest level, reference (1.07), at 7 P.M. August 10. At this time the gauge 75′ away read (3.04) and the gauge 120′ away was barely affected, being reduced from (4.05), the general level of the ground-water at that time, to (4.03).

FIG. 1.



North-west Mortar Pit.
Pump, Pipes and Well Points in position.

Scale
12 0 1 2 3 4 5 6 7 8 9 10 20 30 Feet.

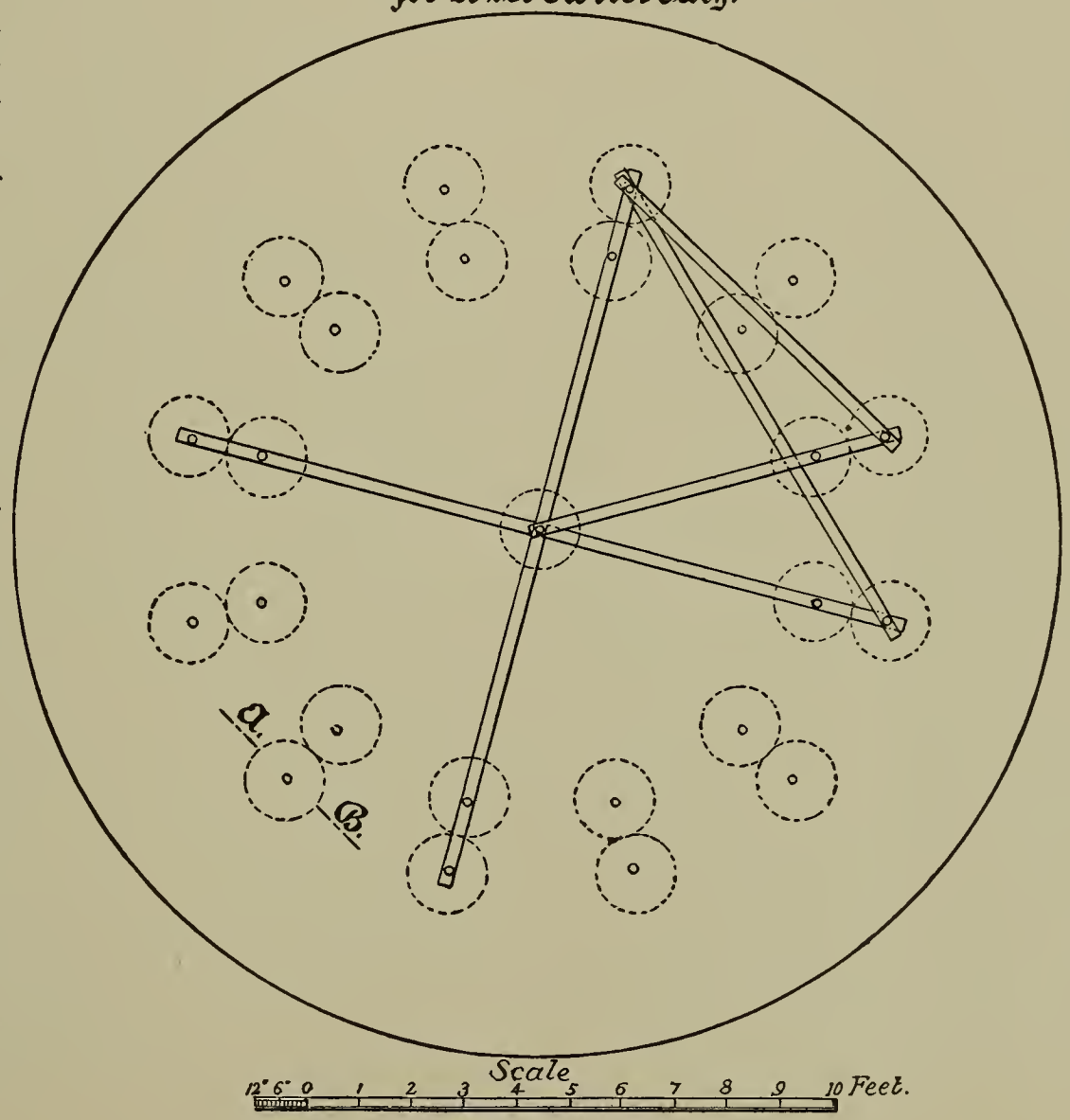
In subsequent work, when the ground-water stood at a higher level and when there was a bed of coarse gravel 3′ thick underlying the foundations, it was necessary to increase the number of well points by six, and to use a second pump.

Template for Setting Bolts. — "The bolts, 24 in number, that hold the roller path to the platform, extend entirely through the concrete foundation, where they are held at the bottom by washers. As the setting of these bolts is an operation requiring great accuracy, it was thought best not to attempt it while the foundations were being put in; and their subsequent setting and adjustment was provided for in the following manner:

At the bottom of the excavation, and about where the head of each bolt would come, was placed a small layer of concrete about 2 feet in diameter and 6 inches thick. This was rammed in place, and an empty cement barrel inverted over it. The foundation was carried up around these barrels, thus leaving holes 18 inches in diameter that allowed a large latitude in setting the bolts. The upper head being left in the barrel kept the hole clear during the progress of the work and until the time came for setting the bolts. The concrete at the bottom of the hole kept the sand from flowing in when pumping was stopped, and also served as a support for the head of the bolt during the operation of setting.

"Fig. 2 shows the method used for setting the bolts. A skeleton frame, or template, swinging on a fixed centre, served to hold the bolts in position after the centre had been accurately located and one bolt set at the proper distance from it. The pieces of the template were not fastened together, but were simply swung over the bolts to hold them in place, the bolts being plumbed and supported at the proper level from below. The barrels were broken up and entirely removed preparatory to setting the bolts. The holes being full of water, the concrete in which the bolts were to be set was lowered to its place in bags, where it was deposited and tamped in place. The sections of the template were moved progressively around the circle as the bolts were set. The bolt at the centre was set in a temporary mound of concrete, which was afterwards broken up and removed."

FIG. 2.
Template for setting Anchoring Bolts for Lower Roller Path.



Further details of these methods can be found in Appendix 2, Report of the Chief of Engineers for 1894, from which the above descriptions were mainly taken.

The numerous old-style fortifications along the coast receive minor repairs annually. The amounts expended on these are small, and the work is usually done by hired labor.

DREDGING.

Laying Out Work and Supervision.—On a few of the more important works the United States owns a dredging plant, but for the most part dredging is done by contract. The chan-

nel to be dredged is carefully surveyed and mapped by the engineer in charge of the work. The amount of excavation required is computed and the nature of the material forming the bottom is determined as fully as possible by borings.

The limits of the required cut are marked by ranges, which may be objects on shore, piles, or buoys. In tidal waters, or where fluctuations of level are to be expected, a plainly marked gauge is set up, when possible at a point visible from the proposed cut. The required depth is measured from a fixed plane—in tidal waters, that of mean low water. These necessary channel-marks are placed under the direction of the engineer. Frequently the contractor is required under the provisions of his contract to furnish and place them. The contractor is made responsible for the care and preservation of all channel-marks, ranges, tide-gauges, etc.

The dumping-ground is selected as near the site of the cut as possible, subject to the condition that the dredged materials shall not find their way to and obstruct any navigable channels. When the materials are to be deposited on shore special arrangements are made which will be described later.

The guaranteed rate of progress and the dates for beginning and completing the work are specified in the contract, as well as the minimum amount of plant to be employed. In certain cases the contract also specifies that incompetent or disorderly employees must be discharged on requisition by the engineer in charge.

The precise location of the work to be done is fixed by the engineer in charge or his assistant. An allowance of from one half foot to one foot is ordinarily made for irregularities left in the bottom by the dredge. That is, to insure that the minimum depth of channel shall be attained throughout, the contractor is permitted to cut slightly below this depth, and when such excess does not exceed the allowance the material dredged is paid for. Material dredged from outside the fixed lines or from below the permitted depth is not paid for.

Dredging operations are at all times under the personal supervision of an agent of the United States, called an Inspector. It is he who, under instructions from the engineer in charge, determines the proper position for the dredge and the width and depth of the cut at any point.

Measurement of Dredged Materials.—Dredging is paid for by the cubic yard, as determined by the measurement of the dredged material, either in scows or in place. When scow measurement is to be used, the capacity of the bins is carefully computed and the contractor is required to fill the bins each time to the same extent. The duty of determining whether the scows or barges contain "full" loads devolves upon the Inspector. In cases of partial loads, he also decides as to the true amount. When rocks or bowlders are dredged along with soft material, but at a different rate of payment, the decision as to the true proportions of each class of material rests with the Inspector also. Payments are made on monthly estimates, 10% usually being retained until the completion of the contract.

Relative Volumes, Place and Scow Measurement.—When the dredging is to be paid for by measurements in place, the volume of the dredged material is computed from accurate and carefully located soundings, made before and after dredging. The increase of scow measurements over measurements in place is for rock generally 1.75 to 2 times. But this increase of volume will be found to vary greatly, according to the nature of the rock and the action of the explosive upon it where blasting has been resorted to. Experience in the rock cuts in the channels between the Great Lakes has shown that "where the rock is broken and to some extent pulverized, the scow and bank measurement approach. If the fragments are large the percentage of difference increases.*" For sandstone and limestone rock in these localities the increase has been about 30 per cent. Both for sand and for rock the volume of voids in a mass becomes greater as the fragments approach uniformity in size.

The increase for other materials is as follows: Very soft mud,

* Col. O. M. Poe, Corp. of Engrs. Bat., Brig. Gen. U. S. A., Engineer in charge.

13%; soft blue mud, 15%; hard sand with small admixture of silt, 20% to 30%. Loose muck, dredged from a reservoir, was found to measure 15% to 17% less in the dredge-bucket than when in place. In hydraulic dredging, particularly where there is much fine, light material, place measurements equal or exceed the scow measurements.

The contractor is further required to furnish proper sleeping accommodations and board to all agents of the United States employed on or about the dredges, and also, when required, to furnish a boat for making soundings, etc.

Dredging Estimates.—The formation of an accurate estimate of the probable cost of dredging in any given locality presents a difficult problem, and it is nearly equally disadvantageous to have the contract for the work either too high or too low. In forming a dredging estimate the following items should be considered, viz., total amount of work to be done; probable average dredging per day, depending upon material, depth of cutting, range of tide, depth of water, and exposure of site; distance to dumping-ground, or cost of depositing dredged materials on shore; distance of site of work from dredging plants, and risks attending a passage thither; value of plant required; interest on value of plant and percentage of depreciation for time required for the work; fire and marine insurance on plant; repairs to plant; operating expenses; contractor's profit.

On December 30, 1892, the United States advertised for proposals for dredging in the harbor of Philadelphia. The estimate made at that time by the officer in charge of that work, of the cost of the dredging, contains reliable data on the cost and operating expenses of dredging plant which are of general application. With his permission this estimate is given below.

The general project was to form a channel outside the pier-line of Philadelphia, about 2000′ in width, and about 7 miles long, with a cross-section of about 55,000 sq. ft. at mean tide. The channel was to be 26′ deep for 1000′ and about 12′ deep for the remaining width. The range of tide is 6′. This entailed the removal of Smith and Windmill Islands (8 acres and 17 acres, respectively, about 9′ above mean tide), and of a portion of Petty Island, and the deepening of the shoals, in all about 17,000,000 cu. yds. place measurement (estimated at 21,500,000 cu. yds. scow measurement). The material was clay, silt, sand, coarse gravel, and small bowlders. From 2,000,000 to 5,000,000 cu. yds. of the dredged material was to be deposited on League Island, 4 miles below, at designated points, and evenly spread; another portion was to be dumped in side channels, with a maximum tow of 12 miles; the remainder was to be disposed of by the contractor, subject to the approval of the engineer in charge.

The following is the engineer's estimate:

PHILADELPHIA, PA., January 28, 1893.

Estimate of the probable cost, with a suitable plant, of the improvement of Philadelphia Harbor, under the specifications dated December 30, 1892:

Dredges.

3	combination dredges* complete at $35,000	$105,000	
7	" " without clam-shells, $33,000	231,000	
10	Total cost of dredges	$336,000	
Interest and depreciation, 10 per cent†			$33,600
Fire insurance, 1 per cent			3,360
Marine insurance, 1¼ per cent			4,200
Repairs, 9 per cent‡			30,240
Operating dredges, including wages, fuel, oil, waste, rope, etc., an average of $694.00 per dredge per month during a season of 10 months $694.00 × 10 × 10			69,400
Total cost per year of dredging and depositing in scows			$140,800

* *Cost of Dredges.*—This is the present average cost of first-class dredges suitable for this work, according to information obtained from builders and buyers.

† 10% per year for interest on and depreciation of plant is invariably allowed by the Clyde Trust Co. in their statement of cost of work.

‡ 9% per year of the original cost of dredges employed on the Clyde in the years 1871 and 1872 was the average cost of repairs of dredges.

Scows.

60 scows, * each of 250 cu. yds. capacity, $5,500	$330,000	
Interest and depreciation, 10 per cent		$33,000
Fire insurance, 1 per cent		3,300
Marine insurance, 1¼ per cent		4,125
Repairs, 7½ per cent †		24,750
30 scow men at $50 per month for 10 months		15,000
Total cost per year for scows		$80,175

Towing Scows.

2 large tugs for towing between dredges and dumping-ground, cost at $30,000	$60,000	
4 tugs at dredges for handling scows at $15,000	60,000	
3 tugs at dumping-grounds at $15,000	45,000	
Total cost of tugs	$165,000	
Interest and depreciation, 10 per cent		$16,500
Fire insurance, ¼ of 1 per cent		825
Marine insurance, ¾ of 1 per cent		1,238
Repairs, 7 per cent ‡		11,550
Running expenses for 2 large tugs, night and day at $1,480 each per month for 10 months		29,600
Running expenses of 4 tugs at dredges, each $410 per month, day work, $410 × 4 × 10		16,400
Running expenses of 3 tugs night and day at dredging-grounds, $820 × 3 × 10		24,600
Total cost of towing per year		$100,713

Miscellaneous.

Amount brought forward	$321,688
Salary of general superintendent per year	3,600
Expense of tug per year for general use	6,835
Fixed charges, being officer's salaries, office rent, and all other office expenses	13,500
Grand total cost per year	$345,623

Average amount of dredging per year, estimated at 3,500,000 cu. yds.

$$\frac{\$345{,}623}{3{,}500{,}000 \text{ cu. yds.}} = 9.875 \text{ cents per yard.}$$

"Estimating 1,500,000 cu. yds. of hard material, consisting of a mixture of sand, gravel, bowlders, and clay, at Petty Island, at an additional price of 10 cents per yard, and dividing the amount ($150,000) by the estimated total quantity to be dredged (21,500,000 cu. yds.) and adding the result to the cost per cubic yard first obtained, we have 1,500,000 cu. yds. × 10 cents ÷ 21,500,000 cu. yds. = 0.698 cent additional cost per cubic yard, which added to the (9.875) cost per cubic yard first obtained, makes 10.573 cents the total average cost per cubic yard to be dredged; to which should be added 15 per cent for contingencies and the contractor's profit, making for the contractor's price 12.159 cents per cubic yard to be dredged.

"In making the foregoing estimate the difficulty of disposing of a large portion of the material to be dredged was not considered further than to assume that about 2½ millions of cubic yards could be deposited within the harbor, and to estimate for the remainder as if it could be dumped at League Island and below Fort Mifflin, or with equal facility. But we know from surveys and computations that the capacity of these dumping-grounds is only from 8,500,000 to 14,000,000 cubic yards, the unknown quantity being the amount that will be required by the Navy Department on League Island; and

* *Cost of Scows.*—The cost of scows varies according to capacity, being relatively more for small scows than large ones. The size adopted in this estimate is considered the best adapted for this work.

† *Cost of Scow Repairs.*—There are no scows like ours in use on the Clyde. There the dredged material is conveyed in "Punts" and "Steam Hopper Barges." The Punts are deck scows holding about 8 cubic yards, used when the material is deposited on land, and for this purpose the loaded Punt is beached and the material is wheeled ashore. They are of light construction, to secure light draught; are subject to rough usage, and the repairs average 9.72 per cent of their cost per year. The Steam Hopper Barges are a combination of tug and scow. They carry the material out to sea, and are bottom-dumpers. They are much less exposed to bumps and strains than our scows, and the annual repairs average 6$\frac{3}{10}$ per cent of their cost. In our estimate we have adopted 7½ per cent of the cost of scows as the average yearly cost of scow repairs in this country, based on many sources of information which substantially agree.

‡ *Cost of Tug Repairs.*—In our estimate we have adopted 7 per cent of the original cost as the yearly expense of tug repairs, based on information obtained from the most reliable sources. This is $\frac{7}{10}$ of 1 per cent higher than the cost of Steam Hopper Barge repairs on the Clyde.

that the contractor will have to provide room for from 7,500,000 to 13,000,000 cu. yds. If only the minimum quantity should have to be placed ashore without any recompense from the owners of the low lands thus reclaimed, the cost would exceed any possible profit that might be otherwise derived from all the work.

"Apropos of this question, the following is quoted from the Minutes of Proceedings of the Institution of Civil Engineers on the subject of disposing of material dredged in the Clyde River, Scotland:

'Previous to 1862, the whole of the dredged material was deposited on land at the cost, in 1861, of 10.3 pence per cubic yard for depositing alone, exclusive of interest on cost of, or allowance for, depreciation on the plant employed. Many acres of alveus thus reclaimed became the property of the riparian proprietors, who are now (1873) asking from £1200 to £1400 per acre for it.

'The difficulty of making reasonable arrangements with landowners for permission to deposit dredgings on the alveus, and on the low land adjoining the river, and the great cost of doing so, when the landowners, for valuable considerations, in the shape of rent, or the acquisition by them of the land reclaimed, gave permission, led the Trustees in 1862' to adopt steam hopper barges, for the purpose of conveying the dredgings to sea. The result for 1870–71 was, that the cost of conveying 673,240 cubic yards of dredgings, and depositing them in Loch Long, 27 miles from Glasgow (an average distance of 20 miles from the dredging-ground) was 5.46 pence per cubic yard, 1.84 pence of that sum per cubic yard being 10 per cent on value of barges for interest and depreciation.'

"But notwithstanding the experience described on the Clyde, it is difficult to believe that here on the Delaware where so much land might be reclaimed and made valuable by the deposition upon them of dredged material, that such co-operation may not be possible as will more equally benefit both the contractors and landowners. Yet it is a risk which no prudent contractor would fail to make some provision for in his bid.

"If it be assumed that the mean of the minimum and maximum quantities estimated to exceed the capacity of the available dumping-grounds will have to be placed ashore, and estimate the bare cost at 10 cents per yard, and that this will be divided equally between the contractor and the landowners, we will have 10,250,000 cu. yds. at 5 cents = $512,500; and $512,500 ÷ 21,500,000 cu. yds. = 2.384 cents per cubic yard; and 2.384 + 12.159 previously obtained = 14.543 as a fair bid for the contractor."

The work was divided under three heads, for each of which proposals were asked. The following is an abstract of the bids received, and opened January 31, 1893:

Bidders.	Price per cu. yd. (scow meas.) for excavating and depositing material at places approved by the engineer officer in charge (21,500,000 cu. yds. approximately.)	Price per linear foot for removing pile and timber wharfing or revetment (16,200 lin. ft., approximately.)	Additional price per cubic yard (place meas.) for depositing and spreading material upon League Island (2,000,000 cu. yds., approximately).
A	$0.125	$1.25	$0.14
B	0.142	1.90	0.16
C	0.147	1.90	0.175
	Totals.		
A	$2,987,750.00		
B	3,403,780.00	Bid B was accepted.	
C	3,541,280.00		

DIPPER-DREDGE.

This type is too well known to require description. It is suitable for all classes of digging where there is little wave action, from soft rock to mud, and in depths up to 30 feet. It has a limited side reach and a limited elevation for the deposit of dredged materials. It is relatively most economical for heavy digging at moderate depths. When working in open water a tug and two or more dump-scows are required as tenders.

Cost of Work with Dipper-dredges.—The cost of work varies so much with the locality and with the material that figures for one locality can be taken for a basis only to a very limited extent in estimating for another. The figures given in the following pages must

then be taken simply as examples of what work has cost under the given circumstances. Where competition is good, contract prices for work are generally as close as prudence will permit with the risks, interest on investment and percentage for deterioration of plant considered.

Cost of Work, Ohio River.—The Ohio River Improvement Dredging Fleet consists of two excellent dipper-dredges, three side-dumping scows, and one hired towboat as tender. The following statement of the cost of work is taken from the annual report of the Chief of Engineers, for 1893 :

The "day of work" is for 10 hours' operations of the two dredges, with three dump-scows and one dredge-tender. The towboat "John C. Fisher," chartered as dredge-tender, was paid $42.50 per day, this amount covering the cost of the boat, outfit, crew, and fuel for the towboat and dredges, except that the cost of coal in excess of five cents per bushel was repaid by the Government.

Time.

At Work, Days.		Lost, Days.	
Dredging sand	18.0	Travelling	8
Dredging loose rock and sand	16.0	Accidents	1
Removing snags	0.6	Low water	4
Removing wrecks	0.8	Sundays	8
	36.0		21

Total days in commission, 57.

Work.

Sand excavated per day of work	1,346.1 cu. yds.
Sand excavated during the season	24,230.6 "
Loose rock and sand excavated per day of work,	1,012.4 "
Loose rock and sand excavated during season	16,805.5 "
Total excavation during season	41,036.1 "
Snags removed, 8	21.9 tons
Wreck removed, coal-boat	1

Cost.

Equipment, for the season	$130.81
Towing and fuel, for the season	3,002.25
Repairs, for the season	133.33
Salaries, for the season	2,479.95
Total cost, for the season	5,746.34
Dredging sand, cu. yd.	0.12
Dredging loose stone and sand, cu. yd	0.16
Removing snags, per snag	11.85
Removing wreck	127.70

The above figures do not include the cost of maintaining the dredges when out of commission, repairs, interest, etc., etc.

Dredging in Manatee River, Fla.—The following table gives the cost of dredging with a small dipper dredge in Manatee River, Florida, during August and September, 1887. Depth of dredged channel, 8 feet. Depth of cutting, 2 to 4 feet. Material, mud and sand. Average distance to dumping-ground, 3½ miles. Plant, one dipper dredge, two tugs, dump-scows. Total time employed on work, 48 days.

		Cost.			
Employees.	No.	Days.	Wages, rate per Month.	Board per Month.	Total for Time Employed.
Dredge.					
Captain	1	48	$125.00	$15.00	$224.00
Engineer	1	48	60.00	.....	120.00
Crew	7	48	30.00	.....	504.00
Tug.					
Captain	1	48	90.00	$15.00	161.00
Engineer	1	48	60.00	.....	120.00
Firemen	2	48	30.00	.....	144.00
Deckhands	2	48	30.00	.....	144.00
Tug.					
Captain	1	28	90.00	.....	98.00
Engineers	2	28	60.00	.....	140.00
Firemen	2	28	30.00	.....	84.00
Deckhands	2	28	30.00	.....	84.00
7 cords wood, per day, dredge, at $3 for 31 days					651.00
4 " " " tug " 3 " 37 "					444.00
5 " " " " " 3 for 24 days					360.00
20% on cost, dredge and scows, for 48 days					1,600.00
" " tug for 48 days					160.00
" " " " 28 days					124.44
5 guide-piles at $5 each					25.00
Total cost of work					$5,187.44
Total amount of material dredged					15,302.3 cu. yds.
Cost per cubic yard					33.9 cents.

Time.

Total days worked	25
Average volume dredged per working day	612.1 cu. yds.
Dredge worked	100.1 hours.
Dredge idle, waiting for tug	89.5 "
Dredge idle, repairing machinery	3.2 "
Dredge idle, shifting and moving	57.5 "
Dredge idle, pumping scows	17.2 "

Dredging in Raritan River, N. J.—The dredging-plant of the Raritan River Improvement consists of one Osgood dipper dredge, three light-draught, bottom-dump scows, and one tug. The dredge was built in 1889; hull, 80′ × 30′ × 8′; main engine, 12″ × 18″, double cylinder, with two hydraulic-band friction-drums; swinging-engine, 7″ × 10″, double cylinder; boiler, locomotive, diam. 56″, length 16′ 5″, with 56″ × 50″ furnace; turntable, 12′ diameter; boom, angle-iron, 35′ long from centre of hinge-pins to centre of sheaves; sheaves, 30″ diameter; dipper capacity, 2 cubic yards, struck measure; dipper doors, double, swinging both ways so as to allow dipper to fill with water while being lowered; capacity of dredge, 1500 cu. yds. per day, of soft material; cost, $21,720.00. For digging in shale rock a smaller and stronger dipper and handle is substituted. This dipper is armed with strong steel teeth.

Dump scows, each capacity 200 cu. yds.; length, on deck 100′, on bottom 86′; width 30′; depth 6′; four bins, each 19′ long, 19½′ wide at top, 9½′ wide at gates, and 4′ deep; air-chamber, 8′ long; cost, $5490.00. Cost of tug, $6500.00.

In 1889–90 this plant dredged 24,160 cu. yds. of fine, heavy sand from the Shrewsbury River at a cost of 18½ cents per cubic yard (operating expenses and maintenance only). It dredged from the Raritan River 52,214 cu. yds. of coarse sand and shale, in about equal proportions, at a cost of 21.2 cents per cu. yd. (operating expenses and maintenance only).

From July 1892 to June 1893, both inclusive, it was engaged in dredging red shale from the Raritan River. The shale was first partly broken up by surface blasts. 5600 lbs. XX Forcite powder were used in 50-lb. charges, spaced 10′ and 15′ apart. The following statement shows the work of the plant:

Time worked, July 1, 1892, to June 30, 1893.	
Total number of working days	304
Actual time worked, days	175
Time lost, days	129
Average amount dredged per actual working day, cu. yds.	67
Total amount dredged and deposited in dike:	
Sand, gravel, and loose shale, cu. yds.	2,388
Blasted shale rock, cub. yds.	9,287
Expenses:	
Operating, including maintenance while idle	$15,683.64
Repairs	2,396.90
Cost of dredging and depositing, per cubic yard	1.549

For this material the scow measurement was found to be twice the place measurement. For further details concerning the nature of the material, and the cost of removing rock broken by a chisel-boat, see "Rock Excavation," page 53.

Clam-shell Dredge.—This type is also well known. It can dredge economically to greater depths and in more of a seaway than the dipper type. It is also useful for grappling broken rock, and is the type used in clearing away the debris of Flood Rock after the great Hell Gate blast. Its penetrating power depends on the weight of the clam-shell bucket, and it is therefore not so good as the dipper in soft rock or very stiff clay. Nor can a shallow cutting be made as economically with it. A longer side sweep and further and higher delivery can be made with this type than with the dipper. This dredge in open water requires a tug and two or more dump-scows as tenders.

The following table gives the cost of dredging in Vicksburg Harbor in 1888, wiih a clam shell dredge. (Trans. Am. Soc. C. E. vol. xxxi):

Depth of water, about 35 feet.
Material, mud and silt.
Average distance to dumping-ground, about 1½ miles.

The dredge was a powerful one and worked continuously and energetically with double crews.

Daily Wages.	Dredge:	16 laborers	$16 00	
	"	2 engine-drivers	4 00	
	"	2 captains, diggers	8 25	
	"	2 cooks	3 00	$31 25
	Tug:	6 laborers	6 00	
	"	2 captains	8 25	
	"	2 cooks	3 00	
	"	engine-drivers	4 00	$21 25
Subsisting 36 men (including 2 U. S. Inspectors) at 50 cts.				18 00
Coal, dredge, and tug, 6 tons, 24 hours, at 40 cents box				25 00
Incidentals and repairs				10 00
Total daily expenses				$105 50
Average excavation per month			55, 529 cubic yards.	
Cost to contractor			5½ cents per cubic yard.	

This does not include interest on value of plant, percentage for deterioration, or cost of moving plant to and from location of work.

Ladder-and-bucket Dredge.—This is a favorite type in England, but has not been as popular in this country. The dredging is done by buckets attached to an endless chain, moved by a powerful engine longitudinally around a trussed arm which is swung at its upper end from a frame in the boat. The lower end rests on the bottom, and by its weight drives the cutting edges of the buckets into the material dredged. The arm is vertical or inclined, according to the type of the dredge. It can be raised and lowered to suit the depth of water. The buckets discharge into a hopper at the top of the frame, and the the dredged material with a proportion of water, passes to a receiving bin in the boat, across the side to a dump-scow, or ashore by piping. These dredges can work to a depth of 30 feet, and in any material not harder than shale rock. They are largely used in Canada, and there have proved effective and economical. As built in this country they are not usually self-propelling, and require the attendance of a tug and scows.

In Lake St. Peter (Canada), dredging to 24 feet with elevator dredges, the cost in 1881 was 3.8 cents per cubic yard for sand and mud and 69.4 cents for solid shale, these figures covering all charges except interest. (Rep. C. of E., 1882 p. 735.)

Stationary Hydraulic Dredge, Von Schmidt Pattern.—This type of dredge is well adapted for digging comparatively soft materials in still water to depths of 30 feet and delivering the materials ashore, The dredge as used on the Potomac flats improvement consists of a scow, fitted with spuds, and having sufficient displacement to carry the necessary machinery. The machine consists of a large rotary pump, from which the suction-pipe passes over the bow of the boat and thence to the water. The vertical part of this pipe is rigidly suspended from a frame which rotates from one side to the other across the bow of the vessel and allows the lower end of the pipe to describe the arc of a semicircle 60 feet in diameter. In this way the machine makes a cut 60 feet wide at each forward movement. The suction-pipe is telescopic, so that it can be lengthened or shortened as the depth to be made requires. The discharge-pipe from the pump passes over the side and is carried to land on pontoons, and thence to the point of discharge. It is provided with flexible joints. The lower end of the suction-pipe is provided with a cast-iron hood or bonnet 8 feet in diameter.

The material of the channel bed is cut up and agitated at the mouth of the suction-pipe by a system of knives or ploughs which rotate about a vertical shaft passing through the centre of the hood. It thus is disintegrated and mixed with water, so as to be taken up and to pass throught he pump easily. In dredging on the Potomac flats the percentage of solid matter taken up by the pump varied from 10 to 35 per cent, varying with the character of the material, the height to which it is raised, the length of the discharge-pipe, and the velocity

at which the pump was run. 10 to 20 per cent was easily handled under favorable circumstances, with the engines making 125 to 130 revolutions per minute. Working in soft material one of the dredges averaged about 350 cubic yards per hour for days, the length of the discharge-pipe being over 3000 feet and the height of lift above the water-level from 6 to 12 feet. The average amount of material dredged per engine-hour for each of the three machines working on the improvement, in all of the varieties of material found there, varied from 169 to 179 cubic yards, place measurement. The proportion of water was least for mud and greatest for sand, when the velocity of discharge had to be increased also, to prevent the clogging of the discharge-pipes. When pumping sand much time was lost for repairs due to injury to the pump from the sand.

The discharge was made into basins formed by low embankments. The material as discharged formed low conical heaps, the heavier portions being dropped close to the exit from the pipe, and the lighter parts being carried to some distance. Referring to the class of work at the flats, the Engineer in charge reports that this mode of dredging "has advantages over any known method in that it requires but little or no labor to spread the material out to any required grade, and it makes a smooth and even bottom, so that the amount of dredging to get a certain depth of water can be estimated with more exactness." (P. 929, Rep. C. of E., 1885, pt. 2.)

The contract price for the work on the Potomac Flats ranged from 12.37 to 15.45 cents per cubic yard, place measurement. A full account of the work can be found in a paper by the Engineer in charge of the work, Lieutenant-Colonel Hains, Corps of Engineers, U. S. A., printed in vol. xxxi, Transactions American Society of Civil Engineers.

A later type of this dredge was used in 1892–3 by the San Francisco Bridge Company, now the "New York Dredging Company," in a contract for dredging in St. John's River, Florida. Their dredge, the "Florida," is 125′ long and 35′ beam. "A truss called the 'ladder' is fitted into a recess in the bow of the hull. The ladder is hinged at a point near the deck of the dredge, and is long enough to dredge to a depth of 30′ from the water-surface. At the outer end of the ladder is placed a cylindrical frame 5′ in diameter and provided with eight knife-shaped blades, which are fastened spirally around the frame. A shaft connects this cutter with an independent engine, placed on the upper end of the ladder and supplied with steam through a flexible pipe. Immediately beneath this shaft is the suction-pipe, 20″ in diameter. This pipe extends from the upper end of the cutter to the centrifugal pump which is connected directly with a triple-expansion engine. The discharge-pipe, also 20″ in diameter, is carried ashore by means of pontons. This pipe is made of sheet iron, and is used in sections 32′ long. Each section is placed on a ponton, and the sections are connected between the pontons by a piece of rubber tubing.

"The hull is anchored in position by a large spud in the stern. A guy-line is run out from each side of the bow, and the work is done by swinging the dredge on the spud as a centre back and forth until the proper depth has been obtained. The average width of the cut is 120′, but a cut 140′ in width can be made by this machine with one swing.

"The average number of revolutions of the pump is 220 per minute. The best work for one day, so far reported, is 5842 cu. yds. for twenty-two hours. The average amount removed per hour is 116 cu. yds." (Rept. on work at Dames Point, St, John's R., Rep. C. of E., 1893, p. 1622.)

In later work in the Potomac River a similar machine is reported to have dredged an average of 285 cu. yds. per engine-hour, in material similar to that in St. John's River—mud with a large admixture of sand. The contract price for the work in St. John's River was 14 cts. per cu. yd., place measurement; for the work in the Potomac River, 14 cts. per cu. yd., place measurement, including the cost of the necessary embankments.

Movable Hydraulic Dredge.—This type of machine was invented

at Charleston, S. C., in 1855, by a Mr. Lebby, and was first used in dredging in Charleston Harbor in 1857. The type was revived in this country in 1871 by Captain Ludlow, assistant to General Gillmore, and was used by these officers for dredging on the bars of the Southern harbors, where on account of the heavy seas the ordinary type of dredge is of little use. The most important work done in this country by this type of dredge was the deepening of the channels at the Sandy Hook entrance to New York Harbor. The work was carried to completion under contract with the Joseph Edwards Dredging Company, who employed three dredges on the work. The following is a brief description of the "Reliance," the largest of the three :

Dredge "Reliance."—The "Reliance" is a sea-going steamer, 157 feet long, 37 feet beam, and 16 feet depth of hold, schooner-rigged and of about 900 tons burden, with two propellers driven by compound engines. She is fitted with bins having a capacity of from 650 to 700 cubic yards, with conical outlet-valves 30 inches in diameter. She carries two 20-inch Edwards Cataract Pumps, with 18-inch suctions, run independently by two engines of about 175-H.P., each and connected to the pump by belting. The suction-pipes extend through the sides about amidships, and turning, when in use, trail alongside at an angle of from 30 to 40 degrees, with their ends on the bottom, nearly oppcsite the stern of the vessel. At the end each pipe has a heavy drag, or hood, of iron, open on the bottom and arranged to scrape up the sand when the steamer is under headway. A small valve in the drag admits water when the pipe is clogged. To provide sufficient flexibility, about 12 feet of the upper part of each suction-pipe is made of rubber, suitably strengthened. The suction-pipes are raised when not in use by a hoisting-engine, by means of tackle attached to the drag and pipe.

Work at Sandy Hook.—When at work the steamer was kept under headway just sufficient to admit of steering properly. The lift of the pump above the water-level was about 8 feet. For maximum results the pump had to make about 145 revolutions per minute. At this rate the bins were filled in about two hours inside Sandy Hook, where the material was a fine sand mixed with a large proportion of mud. Outside Sandy Hook, where the sand was coarse and clean, the bins were filled in about 35 minutes. The average volume dredged per hour, by bin measurement, from December 1887 to November 1889, was 210 yards in the Main Ship Channel, and 442 yards in Gedney's Channel.

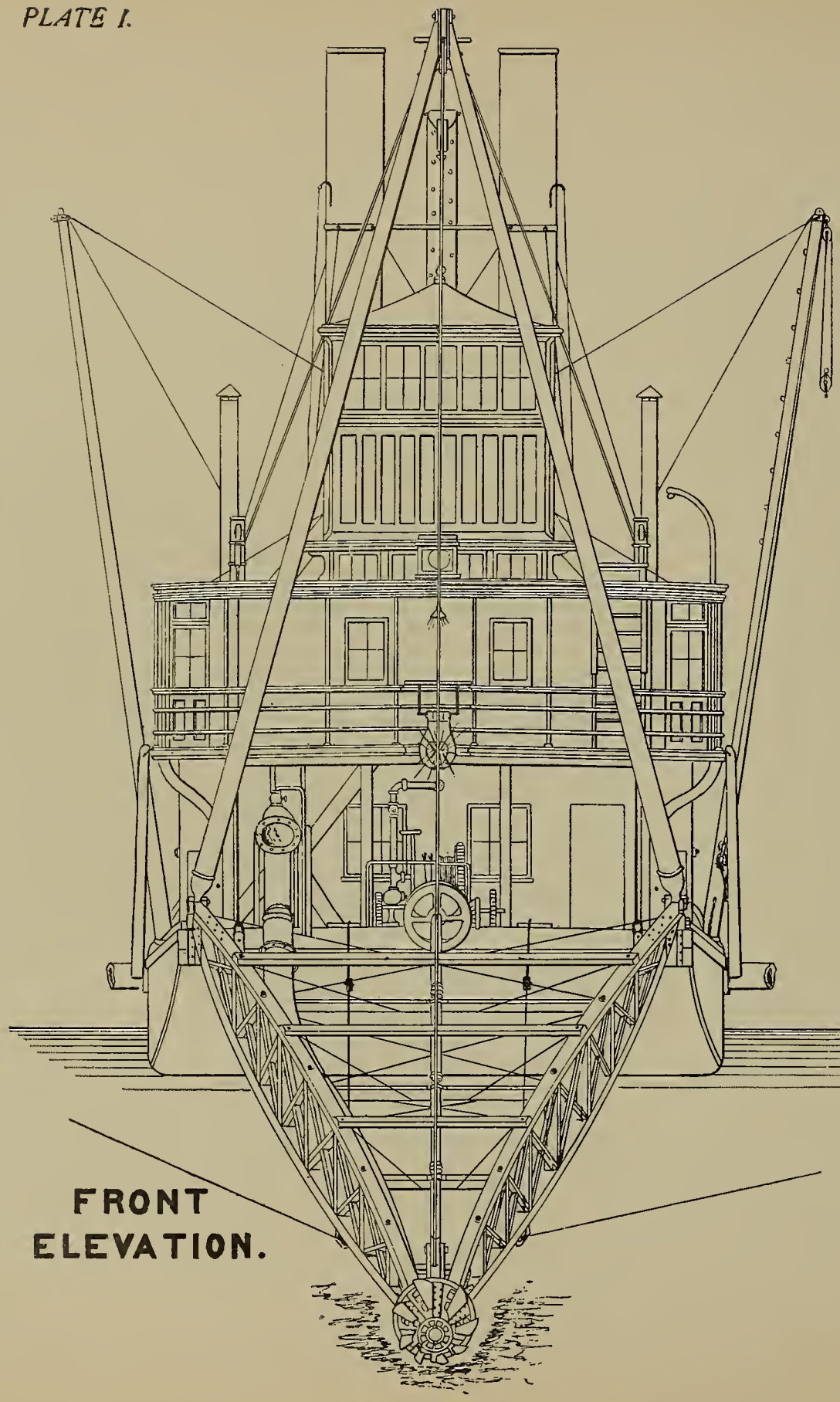
When dumping, a clear stream was turned into the bins from the cataract pumps assisted by streams at high velocity from a double-acting Worthington pump, with a 4-inch discharge-pipe and a 1-inch nozzle.

One of the other dredges used at Sandy Hook was not fitted with bins, but discharged into scows alongside. She was thus able to dredge continuously, without interruptions for dumping. But she could not be used when there was any sea on, and in the end was not as economical as the Reliance.

The contract price in 1890 for this work was 22.6 cents per cubic yard, bin measurement. The estimated cost to the contractor was 16 cents per cubic yard. A detailed description of this dredge, with illustrations, and of its work at Sandy Hook is printed in vol. xxv, Trans. Am. Soc. C. E., p. 573 *et seq.*

U. S. Dredge "Charleston."—The United States dredge "Charleston," in use on the Charleston Harbor improvement, is also of this type. This dredge is 122.5 feet long, 30 feet beam, and 12 feet depth of hold. She has one propeller, 7 feet in diameter, turned by a steeple, compound, Sullivan engine, with cylinders 17 and 32 inches in diameter, and 22-inch stroke. On her trial-trip, without a load, she had an average speed of 10 miles per hour. Her pumping machinery is of the B. C. Howell pattern, and consists of a 230-H.P. compound engine, coupled direct by a shaft to a centrifugal pump, having a 14½-inch suction and a 15-inch discharge-pipe. Her maximum bin capacity is about 270 cu. yds. She requires a crew of 16 men. During the month of March 1893 her daily work ranged from 2100 to 2500 cu. yds.

PLATE I.



FRONT
ELEVATION.

RIVER HYDRAULIC DREDGES.

U. S. Dredge "Ram."—A hydraulic dredge adapted for work on river bars has been constructed recently by the Bucyrus Steam Shovel and Dredge Company, for the United States, for the use in the 4th District, Mississippi River (see Plate I). This dredge is a light-draught stern-wheel steamer, with scow hull, 95 feet long, 27 feet beam, and 7.5 feet deep. Hinged horizontally to the bow, on the two sides, are the ends of a trussed A frame, bearing at the point a cutter, in shape a truncated cone, armed with steel blades and arranged to revolve axially on a steel shaft, which runs from a thrust-bearing at the middle point of the bow to the point of the A frame. The cutter-head is slotted so that materials loosened by the blades may pass inside the cutter-head to the mouth of a 15-inch suction-pipe which opens through the end of the A frame, inside the base of the cutter-head and below its axis, and passes thence to the bow, where it is jointed. The point of the A frame can be set at any position, from a depth of 30 feet below the water-surface, the maximum depth for dredging, to nearly vertically upward, by means of a tackle, from shear legs on the bow of the boat, actuated by a steam-power winding-drum. In moving, the cutter and frame are hoisted until clear of the water.

For making a cut, the boat is swung by side lines from steam-power drums, around a pivot formed by a single strong spud which passes through the boat on the line of the keel, at the forward end of the stern-rake.

The driving-power for the pump is furnished by a compound, condensing, horizontal engine, of 20″ stroke, H.P. cylinder 14½″ diameter and L.P. cylinder 26″ diameter. The cutter-shaft and hoists are driven by a pair of auxiliary engines, 12″ stroke and 9″ cylinder diameter. The pump is Edwards' pattern, 15″ centrifugal, driven by a rubber belt.

The discharge-pipe is carried back beneath the deck to near the stern and thence outboard, where it can be extended to any distance by the usual methods.

The dredge was tested successfully for a capacity of 300 cu. yds. per hour, working in soft mud, and discharging over a bank or bar not less than 10 feet above the water-surface and with point of discharge not less than 300 feet distant. The officer in charge of her work (in 1894) considers her "a practical success for the service for which she was designed."

Operating Expenses.—The following tables show the daily expenses of the boat while running with single and double crew, respectively:

Single Crew.

1 master,	$140.00	per month;		1	day,	$4.67
1 engineer,	90.00	" "		1	"	3.00
1 engineer,	85.00	" "		1	"	2.83
1 engineer,	60.00	" "		1	"	2.00
1 fireman,	45.00	" "		1	"	1.50
1 cook,	50.00	" "		1	"	1.67
1 cabin-boy	25.00	" "		1	"	.83
1 watchman	45.00	" "		1	"	1.50
1 deck-hand	40.00	" "		1	"	1.33
6 deck-hands,	35.00	" "	each;	1	"	7.00
Total for services per day.....						$26.33
Cost of rations for 15 men for 1 day,						3.90
Cost of coal per day, 10 hours' work (35 bbls. at 37½ cents per bbl.).						13.12
Total cost per day.....						$43.35

Double Crew.

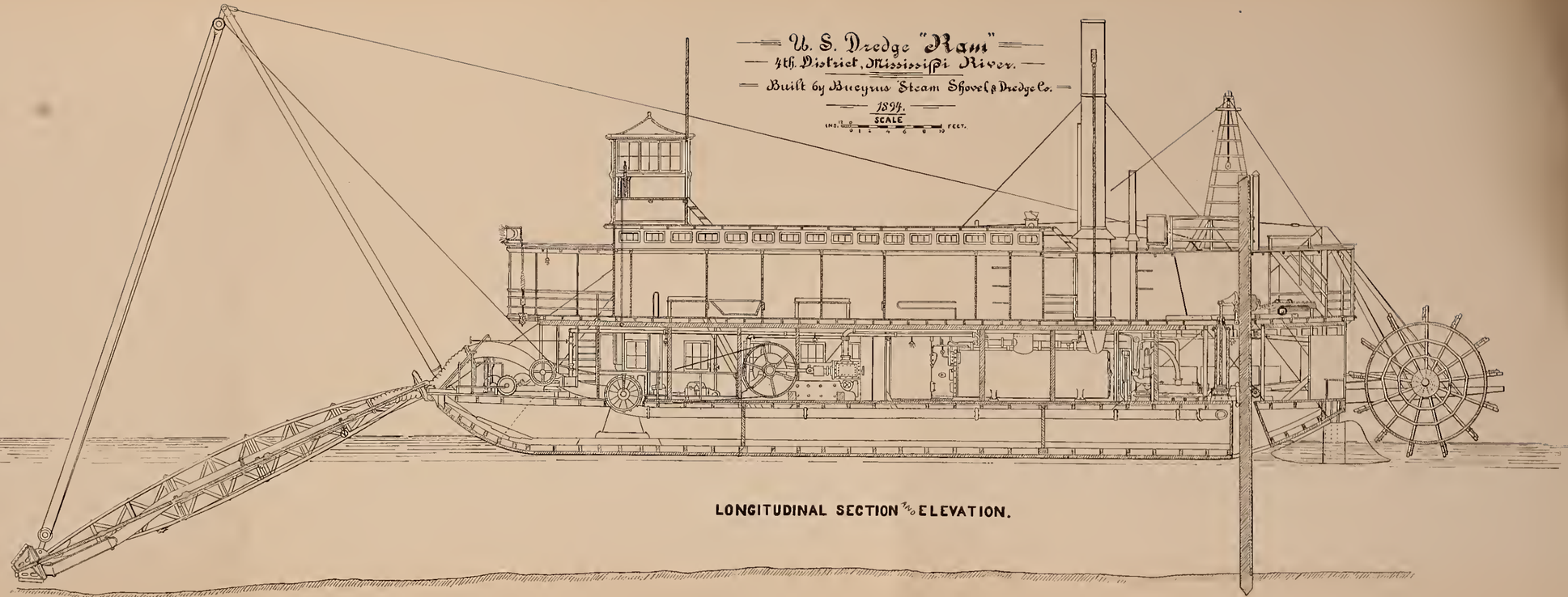
1 master,	$140.00	per month;		1	day,	$4.67
1 engineer,	90.00	" "		1	"	3.00
1 engineer,	85.00	" "		1	"	2.83
1 engineer,	75.00	" "		1	"	2.50
2 engineers,	60.00	" "	each;	1	"	4.00
2 firemen,	45.00	" "	"	1	"	3.00
1 watchman,	45.00	" "		1	"	1.50
1 cook,	50.00	" "		1	"	1.67
1 cabin boy,	25.00	" "		1	"	.83
1 deck-hand	40.00	" "		1	"	1.33
13 deck-hands,	35.00	" "	each;	1	"	15.17
Total for services per day.....						$40.50
Cost of rations for 25 men for 1 day,						6.50
Coal per day, 20 hours' work 70 bbls. at 37½ cents per bbl.....						26.25
Total cost per day						$73 25

PLATE I.

FRONT
ELEVATION.

U. S. Dredge "Ram"
4th. District, Mississippi River.
Built by Bucyrus Steam Shovel & Dredge Co.
1894.

SCALE
IN FEET. 0 2 4 6 8 10



LONGITUDINAL SECTION & ELEVATION.

Dredge "Suwanee."—This boat was built in 1888, for use in the shallow waters of the west coast of Florida as a snag-boat, pile-driver, or dredge, and in its original form is described in the Reports of the Chief of Engineers for 1889 and 1890, p. 1350 and p. 1598, respectively. Since then some details of the dredging apparatus have been elaborated and patented by Mr. J. W. Sackett, of St. Augustine, Fla.

The boat is a wooden stern-wheel steamer, drawing 33″ loaded. The hull is scow-modelled, 80′ × 24′ × 5′, strongly built, with two longitudinal bulkheads. She has a tubular steel boiler, 17′ long, 4′ diameter, with 55 tubes and 4′ × 4½′ grate-surface. The two propelling engines have cylinders 10″ diameter and 32″ stroke, and under 90 lbs. of steam, cut-off at two-thirds stroke, develop 29 H.P. The stern-wheel is 9′ long and 12′ diameter, with 11 double buckets. The speed of the boat in still water is 5½ miles per hour.

There is a double-cylinder hoisting-engine, with cylinders 8″ diameter and 12″ stroke, of 32 H.P. under 100 lbs. of steam. It has two drums with friction-clutches and two gypsy-heads. The derrick is an A frame, which when fitted for snagging has a swinging boom pivoted beneath its point. A clam-shell dredge-bucket is used from this boom to remove rock or to do small amounts of dredging.

When large amounts of dredging are required, the boom is removed and a horizontal triangular frame, supported from the top of the A frame and swinging on the boom pivot, is substituted. (See Plate II.) A flexible suction-pipe with a cutter-head, is swung beneath the frame, and connected with a 10″ Edwards rock-pump, driven by the hoisting-engine. The cutter-head is a patented device. It is a heavy, dome-shaped piece, to the base of which is hinged a tilting cutter. As the frame is swung to and fro by wire-rope lines from the drums of the hoisting-engine (shown close to the deck on the plate) lines from the vertical posts at the outer corners of the frame give the motion to the head of the pipe and drag the cutter-head over the bottom. By means of the tilting base, the side of the cutter toward the direction of the motion is opened, and the material of the bottom is scooped up and is carried into the suction-pipe, with an admixture of from 70 to 85 per cent of water. The inboard end of the cutter-pipe is provided with an elbow and hinge collar, over the pivot of the frame. The discharge from the pump leads out across the side, supported in the usual manner. The cutter-head is supported at the required depth by a line from the middle of the outboard side of the swinging frame.

The small pipe shown in the plate beneath the suction-pipe was used for a water-jet, to assist in stirring up the material of the bottom. This was found to be of little use, and has been discarded.

The guides shown in the plate on the outer side of the frame are for use in pile-driving. For this work the suction-pipe is removed and a hammer is hung between the guides. The piles are placed by the aid of a water-jet from the force-pump on the boat.

While dredging, the boat is held in position by two spuds near the bow and outboard. The port spud is arranged in the usual manner. The starboard spud is a "walking" spud, working in a bracket having a long, narrow opening parallel to the side of the boat. The top of the bracket carries a ratchet in which engages the pawl of a movable roller, used to limit the travel of the spud to the rear. This device is patented. It was placed in the boat after the photograph from which Plate II is taken was made, and therefore does not appear in the plate. To move the boat forward for a new cut, the roller is set as far back as desired, the port spud raised, and the wheel started. When the boat has advanced far enough to bring the starboard spud against the roller the wheel is stopped, the port spud lowered, the starboard spud raised and dropped vertically, and clamped in its new position by moving forward the roller.

The rate of actual dredging per hour varies from 75 to 125 cu. yds., place measurement, depending on the character of the material. The cost of dredging, including ordinary repairs, is about 13 cts. per cu. yd. The boat cost originally $10,000.

Scraping.—Where a narrow bar of soft mud or sand lies close to deep water, it can be deepened by scraping or by propeller sluicing. The "Long scraper" acts on the principle of a hoe. It consists of a

U. S. DREDGE AND SNAG BOAT "SUWANEE."
Arranged for Dredging.

strong frame or handle hinged to the back of a scow and arranged so as to permit adjustment for different depths. At the end of the frame are one or more semicylinders of boiler iron or steel, which form the blade of the hoe, and scrape up and drag along the material of the bar.

Propeller Sluicing.—Propeller sluicing is very effective under favorable circumstances. A propeller—the more powerful the better—whose draught is great enough to place her keel close to the bottom, is moored by cables on the up-stream side of the bar, with her stern toward the bar. Her engines are started ahead, and the powerful currents driven by the propeller stir up and carry off the soft materials. The channel can be widened by swinging the boat. As the channel is formed, the boat is dropped back and the process is repeated until the channel has been cut completely through. The eroded materials are not usually carried more than from 20 to 50 feet, and this limits the usefulness of the process.

In 1886 the steamer "Umatilla," 2131 tons, draught loaded 23.4′, single screw, indicated engine-power while sluicing 1116 H.P., working on St. Helen's Bar, Willamette River, Oregon, in 5 days cut a channel 1500 feet long and 200 feet wide, with a depth of 22 feet for a width of 150 feet. While dredging, the propeller worked generally against a breast of sand 15 feet high, with 7 feet of water on its crest. The total running time of engines was 38 hours 36 minutes.

The cost was as follows;

Hire steamship, 6 days, $375.00 per day	$2,250.00
Detention in port before going to work	360.00
Steamboat tender, 8 days, $40.00 per day	320.00
Materials, incidentals, wear and tear, etc	270.00
	$3,200.00

Numerous attempts to deepen bars by water-jets, explosion of gunpowder, etc., have been made, but without success. The materials can be stirred up easily, but are deposited close to the original point of rest. A late device uses air-jets to cause the stirred-up material to rise higher in the water and hence be carried farther before redeposit.

Deposit of Dredged Materials on Shore.—Where the cut is close to the shore the materials can be deposited at once from the dredge. Where the cut is made at some distance, but the conditions are such that the dredge can be connected with the shore by pipes, the materials can be carried ashore by water carriage, as described for the Potomac flats improvement with the Von Schmidt dredges. Where these conditions do not prevail, the material must be rehandled.

One method is to dump the material at a convenient point close inshore, redredge it, and deposit it on tram-cars on the shore for removal. This process is generally quite expensive.

Potomac Flats Works.—Where the material must be rehandled, the least expensive method seems to be by the use of some form of steam pulsometer. The following plant was used for this purpose by one of the contractors for the Potomac flats work. The lifting-plant was located near the embankment on the Virginia side of the flats, where the dredged material from the channel (very soft mud) was deposited from the dump-scows. The pump, a patented one, was a steel cylinder 7′ in diameter and 30′ long. This was set within another similar cylinder of about 9′ diameter. The space between the two cylinders was allowed to fill with water. 36-inch suction and discharge-pipes, provided with inward and outward opening valves, respectively, led from the base of the inner cylinder,—the suction to the river bottom, and the discharge to the high end of a long wooden chute. The pump was set in a hole nearly 30′ deep and the suction-pipe was nearly that depth below the surface. Steam was forced into the inner cylinder to any desired pressure, up to the capacity of the boilers, forcing the contents of the inner cylinder out of the discharge-pipe. The cylinder being filled with steam, the supply was cut off and a shower of cold water from a tank over the pump turned into the inner cylinder. The steam was condensed, a partial vacuum formed, and an inrush of materials through the suc-

tion-pipe took place, filling the cylinder with whatever materials overlay the mouth of the pipe. This charge was driven out as before, and the operation continued in a succession of pulsations, at intervals of about one minute. During the work at the Potomac flats, a 1300-pound stone was picked up and forced out by the machine, and also an iron safe, $25'' \times 16'' \times 14''$.

The high end of the chute was 28′ above the water-level. The inclination necessary to secure a regular flow was found to be only 1 in 25. The material was delivered to points within a radius of 456′ from the high end of the chute. Under favorable circumstances the pump could handle 1500 cu. yds. of material per hour. It required a large amount of steam, which was supplied by a battery of three boilers.

A similar process was employed by the contractors for clearing the reservoir at Newburg, N. Y. In this case the dredged material was deposited by the dredge in a bin in a flat, from which it was sucked and forced ashore through a pipe supported on pontons made of barrels.

The Reclamation of League Island.*—League Island is located four miles below Market Street, Philadelphia, fronts directly on the Delaware River, and is owned by the United States. The middle portion is occupied by the plant of the League Island Navy Yard. The portion now being reclaimed is triangular-shaped, and has an area of 135 acres. It lies directly east of the navy-yard, and originally consisted of a low marsh 3′ above low water, protected from overflow by meadow-banks. Its length on the Delaware River is 4100′ and its greatest width 2200′. Along the Delaware front the Navy Department afterwards constructed a sea-wall 11′ high, and it is behind this that the fill is being made.

The work is being carried on under the general project for the improvement of Philadelphia Harbor, outlined on p. 35. The total area to be filled is $322\frac{38}{100}$ acres. The work is being done under the contract of 1893 by the American Dredging Company of Philadelphia, at the contract price of $14\frac{2}{10}$ cents per yard, scow measurement, for dredging, and an additional 16 cents per yard, place measurement, for all material put on the island. The specifications provide that no allowance will be made for shrinkage or settlement, and that the amount deposited shall be determined at least once every fiscal year by surveys and measurements which shall be final. The fill now in progress will rise when completed to a height on the axis of the island of $14\frac{6}{10}'$ above mean low water, sloping to about 11′ at the water-fronts. It is to be uniformly graded when completed.

Work in 1891–2.—In 1891 and 1892 the contractors for this work used three pulsometer-pumps for depositing the dredged materials on the island.

As finally arranged, the pulsometers were placed on platforms at the edge of the water. The intake pipes were flexible, and their mouths were moved from point to point in the scows which brought the materials from the dredges, by light hand-derricks. The necessary proportion of water was pumped into the scows by auxiliary pumps, and the material was taken from the scows and deposited on the island by the pulsometers.

The largest pulsometer had a cylinder capacity of $15\frac{1}{2}$ cu. yds., with 26″ suction and discharge pipes. The maximum discharge from it was 750 cu. yds. in 29 minutes. Its greatest monthly average per actual working hour was 459 cu. yds.

Work under Contract of 1893.—Under the contract of 1893 the filling is done by the hydraulic process also. The material used is about equal parts of sand and mud, with a varying percentage of gravel. It is brought to the site of work from Philadelphia Harbor in ordinary bottom-dumping scows and deposited in places accessible to the plant in use.

At first this consisted of two hydraulic dredges, viz., "McNee No. 4," and the "Leo." Afterwards the use of the Leo as a dredge

* The account of the operations under the contract of 1893, with the description of the plant and the discussion on its efficiency, was furnished by Mr. Ellis D. Thompson, U. S. Asst., Engr., from data furnished through the courtesy of Major C. W. Raymond, Corps of Engineers, in charge.

PULSOMETER DEPOSITING MUD IN LEAGUE ISLAND, 1892.

was discontinued, its place being taken by a large vacuum-pump locally designated as the "Moore Pulsometer," for which the boilers of the Leo furnished steam.

McNee Dredge No. 4.—This is a scow-built vessel similar to the Von Schmidt dredge, described on p. 40, with the following dimensions and machinery: length of hull, 130′; breadth of hull, 50′; depth of hull, 11′; draught with full complement of coal, 6′.

It has 2 horizontal locomotive-type boilers, 24′ long and 6′ diameter, working with a maximum pressure of 90 pounds, rated at 400 H.P. each; 2 large condensing-engines 20″ × 24″, and 2 smaller engines 10″ × 20″.

The large engines operate a centrifugal pump 8′ in diameter, to the shaft of which they are directly geared; the smaller ones operate auxiliary machinery.

At the forward end of the machine is a "table," so called, carrying the suction-pipe and agitator, which when operating move on the arc of a circle with a radius of 28.5′. The chord of the arc is about 50′. The bow of the boat is rounded to accommodate this movement. The suction-pipe is in four sections, with a total length of 24′; it is telescopic, the lower sections being enclosed by the preceding ones when required. A depth of 18′ at mean low water can be made. The suction has a diameter of 21″; at its bottom is a cast-iron shell, through the centre of which passes a shaft provided with radial branches at the bottom. On these are fastened knives, the whole apparatus being designated the "agitator." By the rotation of the shaft the material is stirred so that it can be readily taken up. The discharge-pipe has a diameter of 24″ and leads over the side. It is then carried on pontons from the dredge to the shore, and thence is laid directly on the fill, its length being added to as the fill progresses.

Each ponton carries a length of pipe 32′ long, the joints between the pontons being made of heavy rubber. Between the dredge and the first ponton are two ball-joints, and between the last ponton and the land pipe two more. These with the rubber connections between the pontons allow a great deal of flexibility to the line of pipe, and enable the dredge to move to and fro in its basin without changing the discharge. The land pipe is rigid.

The dredge operates in an open basin about 400′ long, 75′ wide and 25′ deep, distant 300′ from the sea-wall of the island. In this basin the material dredged is deposited from bottom-dumping scows, either before or behind the dredge, according to its position in the basin. The dredge is held in place in the basin by spuds and anchors in the usual mannner.

In operating the dredge the material is first stirred up by the agitator, then received through the vertical open-mouthed suction-pipe, and to reach the pump passes three right-angled bends, with centre radii of 3′; after leaving the pump it passes three more right-angled bends before reaching the first ball-joint on the pontons. The velocity of flow through the discharge varies with the character of material handled and the revolutions of the pump, these being about 120 per minute for 500′ length of discharge, increasing to 150 for 1500′ length of discharge. For a discharge of 500′ in length the velocity was approximately determined by Mr. Thomas Valentine, U. S. Inspector, as 13′ per second by using the following method:

Velocity Measurement.—A convenient point (a flange-joint) was selected in the discharge-pipe outside the hull of the dredge, and the distance from said point to the end of the discharge carefully measured. A man was stationed at each place; then by signalling the engineer of the dredge the pump was set in motion pumping clear water, which was continued for two or three minutes. A signal was then given the "table" man to lower the suction-pipe into the mud. In a few seconds the water became suddenly discolored, and the times of its passage at the two points of observation were noted, the velocity being determined by a division of the length of pipe by the time. The discoloration of the water as soon as the suction handles mud is sharply defined.

Lieut.-Col. Hains, in his paper on the "Reclamation of the

Potomac Flats" (Trans. Am. Soc. C. E., January, 1894), gives the velocity of clear water through the pipes as varying from 10′ to 15′ per second. It is probably safe to estimate the velocity of discharge when pumping through 1000′ of pipe at 9′ to 11′ per second, and when pumping through 2000′, at 7′ to 8′. This dredge handles from 10% to 20% of solid material with 90% to 80% of water. The present length of discharge is 1200′, and the height of lift at low water from the surface of the water to the point of discharge, 14′. For the total lift, 2′ should be added to this, determined as follows:

Calling the depth of the excavation 12′, and the proportion of solids in the material pumped 20%, we have for the weight of a cubic foot of a 20% mixture, 80% of 62.5 lbs. (water) + 20% of 110 lbs. (mud) = 50 + 22 = 72 lbs. 15% heavier than water. That is, in a suction-pipe 12′ long a column of mixture 10′ high would be balanced by a column of water 12′ high, leaving 2′ additional lift to be overcome by the pump. The velocity of flow through the suction must be not less than 10′ per second, for practical work.

Crew and Work.—This dredge is operated by 1 captain, 1 tableman, 1 engineer, 2 firemen, 2 crankmen, 2 deck-hands, 1 steward, and 1 watchman, and has a monthly coal-consumption, of 216 tons. It started operations September 11, 1893, and up to November 1, 1894, had received 1,104,239 cu. yds. of material, scow measurement. It had worked during the period 3300 working hours, or an average of 334.6 cu. yds. per hour, the average volume of material handled for each working day of 10 hours being 3346 cu. yds. The discharge-pipe has no gravity slope, the whole volume of material being directly forced through its entire length. When the land-pipe is maintained without leaks, the result is an even deposit with a slope of about 8″ in 100′.

Dredge Leo.—This is also a scow-shaped vessel and has the following dimensions and machinery: length of hull, 153′; breadth of hull, 43′; depth of hull, 16′; draught loaded with coal, 12′.

The boat has one double-furnace return tubular boiler of the American type, 400 H.P., and two double-furnace return tubular boilers of the Scotch type. The former boiler is 15′ 3″ length and 9′ 8″ diameter; the latter boilers are 11′ 4″ length and 8′ 10″ diameter and rated 200 H.P. each. It is furnished with a centrifugal pump 6′ in diameter which makes 180 revolutions a minute, with a steam-pressure of 90 lbs. The suction-pipe is about 30′ in length, 16″ diameter, of the type known as the "drop suction," and is provided with an "agitator." It is held in place by a heavy iron hinge, and when in position to operate, the joint at the hinge is made air-tight by screwing the flange close against a rubber gasket. The suction-pipe can be raised or lowered at will. When in use the dredge operates in an unenclosed basin, like the McNee Dredge, No. 4, the discharge-pipe being carried to shore on pontons. The total length of discharge was 700′. The height of lift was 16′; average volume of material handled per working day of 10 hours, 1150 yards; gravity slope of pipe, none, its position on the dump being about level.

This dredge worked from September 1, 1893, to April 12, 1894, a total of 1524 working hours, handling during that time 178,018 cubic yards, scow measurement, or an average of nearly 117 cubic yards per working hour. The kind of material handled was about the same as at Dredge No. 4; about the same percentage of water was used, and the methods were practically the same, except that the pump, being geared 2 to 1, made normally 180 revolutions per minute. This dredge employed a crew of 14 men, consisting of 1 captain, 1 mate, 1 engineer, 1 oiler, 3 firemen, 1 coal-passer, 1 watchman, 4 deck-hands, and 1 steward. Its monthly coal consumption was 243 tons.

Moore Pulsometer.—This is an improved form of the machine described on p. 45. It consists essentially of an upright steel cylinder, dome-shaped on top, 30′ long and 7′ in diameter, enclosed in a larger cylinder of boiler-iron, 11′ in diameter, forming a caisson and holding the valves and ballast for sinking the pump.

As used, it rests on the river-bottom 75′ from the sea-wall. It has one intake pipe, 33″, in diameter, the outer end of which is turned upward and lies at a depth of 33′ at low water. The discharge has a diameter of 33″, increasing to 36″ 120′ from the pump. The increase in the discharge-pipe was made as a matter of economy, 36-inch pipe being easier to obtain than 33-inch. Both the discharge and intake pipes are fitted with clapper valves of the same diameters as the pipes. Steam is admitted to the top of the pump through a balanced gate-valve. At first the water was admitted through a cylindrical pipe with a semi-spherical bottom, the pipe having a diameter of 10″ and being perforated by 3100 holes $\frac{3}{16}$ inch in diameter. It extended down 4′ from the top of the pump. This was afterwards broken and replaced temporarily by a perforated iron plate.

The pump is operated as follows. Steam is admitted, driving out the spoil quickly; water is then admitted in sprays, condensing the steam; a vacuum is formed and the pump fills; steam is again admitted, clearing the pump: and this operation is continued indefinitely. The capacity of the pump and discharge-pipe to the valve is 51 cu. yds., and the pump can easily make three strokes per minute when there is sufficient material to feed it. With some kinds of material a 30-inch vacuum can be formed, but in working the vacuum seldom exceeds 10 inches, the pump filling itself before a high vacuum is formed. Logs 6′ long and 1′ in diameter, and large stones weighing 600 to 700 lbs., have passed through without damaging the pump. The pump is cheaply and strongly built, has no delicate or complicated parts, and is handled by one man, with a fireman to furnish steam; the valves are automatic. The length of discharge-pipe, 36″ in diameter, is 1120′, and its highest elevation above low water, 20′; from the base of the pump the lift is 43′. In this pump the lift is not aided by the pressure of the outside water, and the location of the discharge-pipe is at the bottom of the pump.

The discharge-pipe has a slope of 6″ to 100′. It consists of old boilers riveted together, and is carried on a trestle from the pump to a point on shore where the fill is sufficiently high to sustain it; thence it is laid directly on the fill, its length being added to as may become necessary. The use of old boilers for this purpose has the advantage of providing manholes at frequent intervals, allowing access to the pipe in case it becomes clogged. The pump is supplied with steam from the boilers of the Leo, previously described, and works with a normal pressure of 70 lbs. It handles mud, sand, and a small percentage of gravel. When the latter becomes large and includes boulders, it chokes the apparatus. The best results are obtained with mud. This pump handles about 70% to 80% solid material, with 30% to 20% of water, but better results for spread are obtained when the percentage of water is 25% to 50%. When the amount of water is small, the spoil falls "dead" at the end of the discharge-pipe and chokes it. This apparatus handles about 4300 cu. yds. per day of ten working hours. The spoil is deposited from bottom-dumping scows, a pocket at a time, directly over the intake.

This pump has, under favorable circumstances, handled quantities as follows:

1894, Oct. 11	3,140	yds	4	hours	30	minutes.
" 16	2,627	"	2	"	55	"
" 17	2,911	"	4	"		
" 18	3,076	"	3	"	15	"
" 23	9,038	"	8	"	25	"
" 24	9,297	"	8	"		
" 25	8,810	"	9	"	15	"
" 26	4,182	"	5	"	20	"
" 27	6,736	"	8	"		
Total	49,817	yds	53	hours	40	minutes.

Average for 9 days, 928 yards per hour of working time. Up to November 1, 1894, the pump had worked 663 hours, handling 286,989 cu. yds. of material, scow measurement, or an average of 433 yards per working hour.

It employs a total crew of 23 men, as follows:

1 master mechanic,	3 firemen,	7 laborers,
1 captain,	2 scowmen,	2 stewards,
1 mate,	1 carpenter,	1 watchman.
3 engineers,	1 submarine diver,	

Its monthly coal consumption is 120 tons, or about 1 ton per each hour when operating.

Efficiency of Plant.—In judging the efficiency of the various plants, the supply of suitable material is the governing factor.

In removing the islands from Philadelphia Harbor, much foreign material, used as filling for the wharves, was dredged; and while it is the aim to dump all such material in unused channels, more or less of it is picked up from time to time and carried to League Island, and to this much of the delays may be attributed. Frequently large stones, roots, and small stumps have lodged in the pumps, and, in cases of the centrifugal pumps, pieces of old telegraphic cables have clogged the knives. Material is received at all hours of the day and night. At Dredge No. 4 it is deposited in a storage basin holding from 4000 to 5000 yards, enabling the dredge to work continuously 14 hours daily. At the pulsometer it is pumped ashore only as received, and the apparatus is necessarily idle at other times.

The first place measurement of the fill was made in June, 1894, the results being as follows up to May 31, 1894;

Received at pumps, scow measurement....	909,766 cu yds.
Amount of fill, as determined by survey..	552,956 "

That is, 1 cubic yard of material received, scow measurement, made 0.6078 cubic yards in place on the island. Much loss is undoubtedly due to dumping in open basins, where the spoil is subject to the action of tidal currents, and to material being carried in suspension through the two drainage-sluices in the meadow-banks. In making monthly estimates for payment, 60% of the material received is estimated as being in place in the fill.

The successful working of the hydraulic dredge depends in a very large degree upon the proper management of the suction-pipe, and requires the best skill and judgment of the operator. If the suction is too near the bottom, too much solid matter is carried into the pumps, and clogs them; if too far removed, then only water is pumped. It has been found by experience that any protection or gratings across the mouth of the suctions to prevent the entrance of undesirable material, such as logs, large stones, etc., rapidly create an accumulation there and destroy the efficiency of the pump. In practice, therefore, the suctions are left open. It has frequently happened that large stones have lodged in the pump, and have had to be broken up piecemeal and removed. The rigidity of the suction-pipe, the numerous bends in the pipes which create unnecessary friction, and the absence of a device to exclude undesirable material are the principal defects of the dredge.

At the pulsometer, experience shows that the principal delays are caused by logs and stones obstructing the intake. A diver is permanently retained on the operating force for the removal of these.

In a new improved pulsometer now under construction at the island there are *two* intake pipes, and these are provided with gate instead of clapper valves; the diameters of the intake-pipes are 39″ at the mouth, increasing at once to 40″, thus allowing anything in the shape of stones that will enter them to pass the pump. In case either intake becomes clogged, the other will enable the pump to continue in operation; the gate-valves are arranged to be worked by either hand or steam, and their advantage is, that, by reversing the usual action of the pump, obstructing material can be washed back into the river, and the intake cleared. This cannot be done with clapper valves. The filling of the island is progressing rapidly, the main difficulty at present being the maintenance of the meadow-banks. These, above high-tide line, are found to be full of muskrat and other holes to such an extent that much of the water pumped on the island passes through them instead of the regular outlet-sluices. This has been the cause of several breaches, and of a good deal of trouble and expense to the contractor.

Estimate for Improved 20-inch Hydraulic Dredge.—As the result of past experience at League Island, the American Dredging Co. has designed and now has under construction a new suction-dredge for use there and at Petty Island. This dredge may be considered as avoiding all the objectionable features of the present plant, and to be of the type best adapted to the form of work now being done by it. It differs from the McNee dredge in the following essential particulars, viz: the use of a swinging suction-pipe, 60′ long, with a flexible hose connection, having only two right-angled bends of large radius, instead of six of 3′ radius; an increased number of pump-revolutions (200 to 225 per minute) with a large boiler-pressure (150 lbs.), and an improved agitator apparatus with an arrangement to exclude material larger than $8\frac{1}{2}'' \times 12''$. All parts are arranged especially to reduce friction.

Through the courtesy of Mr. L. Y. Schermerhorn, President of the American Dredging Co., the following detailed statement and estimate of cost of the dredge is given:

ESTIMATED COST OF A 20-INCH HYDRAULIC DREDGE, WITH 2000 LINEAR FEET OF DISCHARGE-PIPE, COMPLETE AND READY FOR WORK.

Hull 120′ × 40′ × 11′ with "A" frames	$16,000
Main engines, triple expansion, 13½″, 21″, 33,″ and 18″ stroke, 220 revolutions per minute, steam-pressure 150 lbs.; cutter-head engines; cutter-head shaft; suction-pipe and hose; centre swing casting; centrifugal pump	18,000
Circulating-pump, surface condenser; swinging-engines; hauling-engines	3,000
Boiler and parts	8,300
Spuds; spud-drivers; frictions, shafting and gearing	1,500
Hauling-heads and drum-frictions	1,000
Steam-pump and water-tanks	800
Steam-pipe and valves with fittings	1,200
Swinging-attachments, chains, etc	700
Wire rope	400
20 pontons 16′ × 18′ × 2′	1,850
2000′ 20-inch wrought-iron pipe, No. 10	2,750
20 gum sleeve-connections	500
2 ball-and-socket joints	200
Connecting boiler and pump, engine-foundations, etc., and fitting machinery	5,000
Total	$61,200

Formulæ for Determining Work of Hydraulic Dredge.—The following may be considered as an example of work done by the McNee dredge in putting material ashore.

Assume the length of discharge-pipe as 1000′, its diameter as 20″, the elevation of the material above the water as 14′, the depth of excavation as 12′, the percentage of mud as 20, or the weight of the discharge mixture as 72 lbs. and the velocity of discharge as 8′; the resultant discharge is 17.4 cubic feet per second.

Let F = friction head;
L = length of pipe in feet;
d = diameter of pipe in inches;
V = velocity in feet per second.

Then by Clark's formula

$$F = \frac{L}{1200\,d} \times (4\,V^2 + 5\,V - 2).$$

Or, substituting and reducing,

$$F = 12.23 \text{ feet.}$$

The velocity head is $V = \sqrt{2gh} = 1'.0$.

The suction-lift from an excavation 12′ deep due to difference in weights of the mixture and clear water is 1′.8.

The friction of bends and joints (NcNee dredge) is estimated equivalent to a head of 4′.0.

Then the work done to secure a discharge of the 17.4 cu. ft. per

second is equivalent to raising a column of water to a height equal to the sum of

Friction-head	= 12.2 feet.
Velocity "	= 1.0 "
Elevation	= 14.0 "
Suction-lift	= 1.8 "
Friction of bends and joints	= 4.0 "
Total	33.0 feet.

The pump makes 125 revolutions per minute, or $2\frac{1}{10}$ per second, and the diameter of the runner is 8′ (circumference 25.1′); its circumferential velocity is 52.7 feet per second, and the theoretical head resulting from such a velocity would be

$$52'.7 = \sqrt{2gh}, \quad \text{or} \quad h = 43'.4.$$

The best standard of efficiency of centrifugal pumps does not exceed 70% of this theoretical.

The actual work accomplished in H.P.

$$= \frac{\text{cubic feet per second} \times \text{weight} \times 60 \text{ seconds} \times \text{height}}{33000}$$

$$= \frac{17.4 \times 72 \times 60 \times 33}{33000} = 75 \text{ H.P.}$$

The engines of the McNee dredge are worked at an indicated H.P. of 300 to 350.

The largest amount placed on the island during one month was 112,400 cubic yards, estimated place measurement, in October, 1894. It was handled as follows:

McNee dredge	67,600 cu. yds.
Pulsometer	44,800 " "
Total	112,400 cu. yds.

ROCK-EXCAVATION.

Inspection and Payment.—As a general rule work of this class is done under contract. The dimensions of the proposed cut are carefully determined and the ranges marked, as for dredging. On land, the work is paid for by the cubic yard, measured in place.

Excavation under water is usually paid for by the cubic yard, scow measurement, when the excavation is of rock and soft materials, mixed, or of boulders, and by the cubic yard, place measurement, for bed-rock. As previously stated, scow measurement exceeds measurement in place generally by from 1.75 to 2 times, but may fall as low as 1.3 times.* Material excavated from outside the prescribed limits is not paid for.

Inspectors have the same duties as in dredging work.

The contractor is permitted to use his own methods, but is held responsible for injury to persons or property resulting from his work. When working in channels used by commerce, he is not permitted to obstruct navigation.

Methods.—The methods adopted for rock-excavation on land, or where coffer-dams are used, are too well known to require explanation.

Rock-excavation under water is carried on with or without the use of explosives. For soft rock in thin strata, or for shale, dipper-dredges, having the nipper armed with steel teeth, have been used with good results. In the lower St. Lawrence River ladder and bucket dredges have also been used effectively for the same materials.

Chisel-boats.—The first recorded use of a chisel-boat for subaqueous rock-excavation was by Major J. G. Floyd, U. S. Agent, in 1855, on the improvement of Des Moines Rapids, Mississippi River. His chisel was a stick of oak timber, 12′ long and 12″ square, shod with a conical wrought-iron shoe weighing about 300 lbs., having a pyramidal steel point. Bars of railroad iron let into the sides of the timber acted as guides, working between uprights set

* See p. 34.

up in the bow of a boat. In the fall of 1857 Major Floyd had new and improved machines made on this principle by J. S. Osgood of Troy, N. Y. In 1872 the machines were rendered much more effective by the invention of a removable steel point by Mr. A. J. Whitney. (Rep. C. of E., 1886, Pt. III, p. 1452.)

Work in Hudson River.—The following is a description of one of these boats as used in the removal of rock from the Hudson River in 1892–93, under a contract with P. Sanford Ross.

The machine is a pile-driver scow, with a guide-frame 65 feet high, having two wrought-iron chisels $8'' \times 12'' \times 36'.5$, swung between the guides. The chisels weigh 6 tons each, and each has a cutting edge of steel, $3'' \times 12'' \times 5'$, set into the end of the wrought-iron bar. The two chisels are set in the guides with their cutting edges at right angles to each other. The chisels are raised and dropped by a double-drum hoisting engine, similar to a pile-driver engine. The boat is swung forward alternately on each of two iron spuds at the stern, by means of wire ropes which run from drums at the stern, worked by an auxiliary engine, over shears at each side of the guides, and thence to anchors dropped to the right and left of the rock to be removed, making concentric cuts, 1 to 2 feet apart. The chisels are raised about 15 feet, and are handled at the rate of six blows per minute, this having been found to be the most economical speed. At that rate the penetration at Austin Rock, a slate formation, was as follows:

First foot	18 blows	3	minutes
Second foot	27 "	4.5	"
Third foot	36 "	6	"

The work was done thoroughly, the rock being broken into pieces from the size of a hen's egg to that of a man's head. The broken rock was removed by dredging,

Cost.—The contract price for breaking up and removing the rock was $5.00 per ton of 2000 lbs. A cubic yard was estimated to weigh about two tons. Similar work, done in that vicinity by drilling from a scow, and blasting in the usual manner, cost $14.80 per cubic yard, place measurement. (Rep. C. of E., 1893, Pt. I, p. 1013.)

Rock Island Rapids Work.—Chisel-boats were used for many years in the improvement of Rock Island Rapids, Mississippi River. The rock there was removed to a depth of $4\frac{1}{2}'$ below low water. It was a limestone of varying hardness, with sometimes patches of soft yellow sandstone. In 1879 the assistant engineer in charge of the work reported: "There is in my mind no doubt at all that subaqueous blasting, in connection with the steam-drill, should be everywhere used where the cutting or breaking of rock is 1′ and more. . . .) I will add that for removing rock under 6″ in thickness the chisel will perhaps be more convenient, especially if the surface is a large one. . . ."

Cost.—On this work the average daily work of the chisel-boat was 10 cubic yards, broken at a cost of $3.50 per cubic yard. The boats used at Rock Island were not as powerful as that described above.

Raritan River Work—Material; Cost.—The following data show the work of an Osgood chisel-boat in the Raritan River during 1893–94. The conditions seem particularly well adapted for economical work with this boat. The material removed was New Jersey red shale, having a specific gravity of 2.65. It was an irregular stratification, the strata varying in thickness from a few inches to several feet. The strata have a dip of about 15 degrees. The depth of cutting averaged 3.′4, the original depth of water was 7′ at mean low water, with a mean tidal range of 5,′6. The rock excavated was measured by the displacement of scows, in tons of 2000 lbs., checked by place measurements before and after dredging. The scow measurement averaged 1.75 times the place measurement. The average daily work of the chisel-boat was 235 tons (2000 lbs.) per day of 10 hours. The estimated operating expenses for the chisel-boat were 15 cents per ton.

The broken rock was lifted with a dipper dredge, at an average

rate of 209 tons per day of 10 hours. The estimated cost of the operating expenses of the dredge was 17 cents per ton, deposited in scow. A portion of the rock was taken to Newark Bay at a cost for towing out of Raritan River of 13½ cents per ton, and for towing into Newark Bay of 32 cents per ton. A portion of the rock was towed 8 miles and wasted, at a cost of 13½ cents per ton.

The rock was broken into pieces which ranged in size from shingle to 3-ton blocks. About one half was one-man stone, one fourth blocks up to 3 tons weight, and one fourth shovel material.

The level of the surface left after the excavation was generally within one half foot of the depth worked for.

Rock Excavation with Explosives.—In the Suwanee River, Florida, the reefs were of soft limestone containing seams and nodules of flint too hard to be drilled economically. The rock was much water-worn and full of crevices, and the depth of water was from 2 to 5 feet. Charges of 2⅔ lbs. of rackarock and ⅓ lb. of dynamite were placed in tin cans 7″ high and 3″ in diameter and sealed with a mixture of wax and paraffin, or sometimes with common soap. These were placed in the rock crevices and covered with large stones. Each can contained a high-power electric fuse. The lead wires from about five charges were joined in series, and fired simultaneously with a No. 3 Rand magneto-machine. The cost per cubic yard of rock blasted and removed was about $3.12. The use of dynamite proved to be unnecessary, and it was discarded in later work.

Where the rock is not so stratified and tilted as to admit of surface blasting, the charges must be placed in holes drilled for the purpose. The following are some of the devices in successful use for providing a solid platform from which to work the drills, and the methods for placing the charges and blasting.

Movable Platform. (See Plate IV.)—One of the smaller-sized platforms in use for about twenty years for subaqueous blasting in the James River is described as follows:

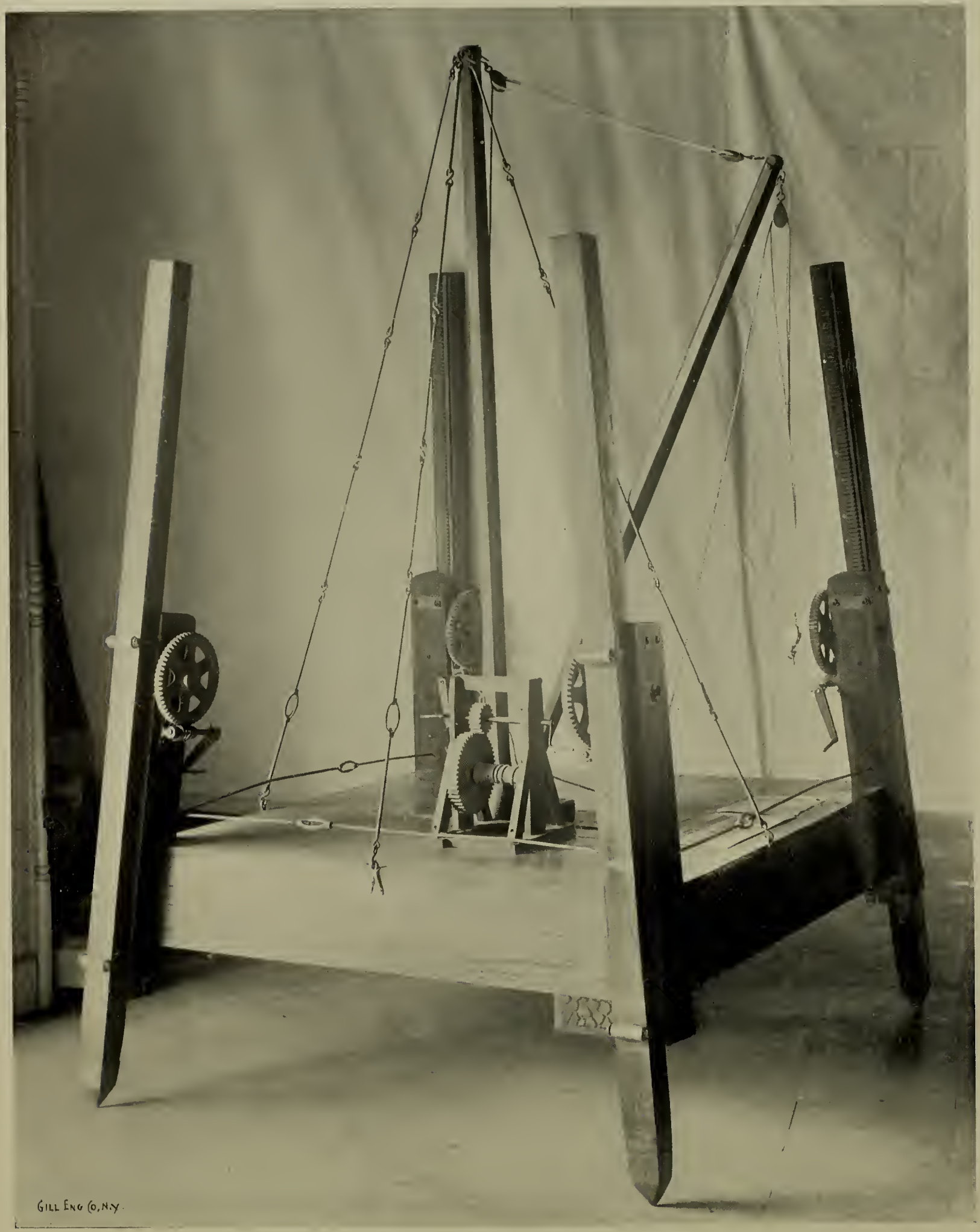
"It consists of a water-tight compartment, about 20′ square and 3¼′ deep. This, when in place for work, is supported by four spuds, 12″ square, resting on the river-bed. The compartment is raised on these by wheel and screw gearing, which acts on a rack on one side of each spud. For this size of platform the compartment is ordinarily raised by four men. When the platform is to be moved, the compartment is lowered and the spuds raised sufficiently from the bottom. The platform can then be towed to any desired point. The small derrick (placed on the platform) is used for handling the steam-drills (two of which can be used at once) and the timber supports to which they are fastened, which can be set vertical or at any desired angle practicable for the depth of water."

James River Work.—"On this improvement (James River) the bottom of the excavation in rock is generally 29′ below the floor of the platform as usually set in place. The steam-power needed for the drills is supplied from a scow which also carries lifting apparatus for raising the larger fragments of blasted rock. Smaller fragments are dredged. The platform is moved away from the charged holes before they are fired. The average depth of holes drilled in 1891–2 was about 7′, and they were spaced about that distance apart. About 1000 linear feet of holes were drilled in a month, including all delays from moving, etc. The splay in the spuds is given to reduce vibration as far as practicable. The spud boxes are made larger than the spuds to meet this splay in raising and lowering the compartment." (Catalogue War Dept. Exhibit, World's Columbian Exposition.)

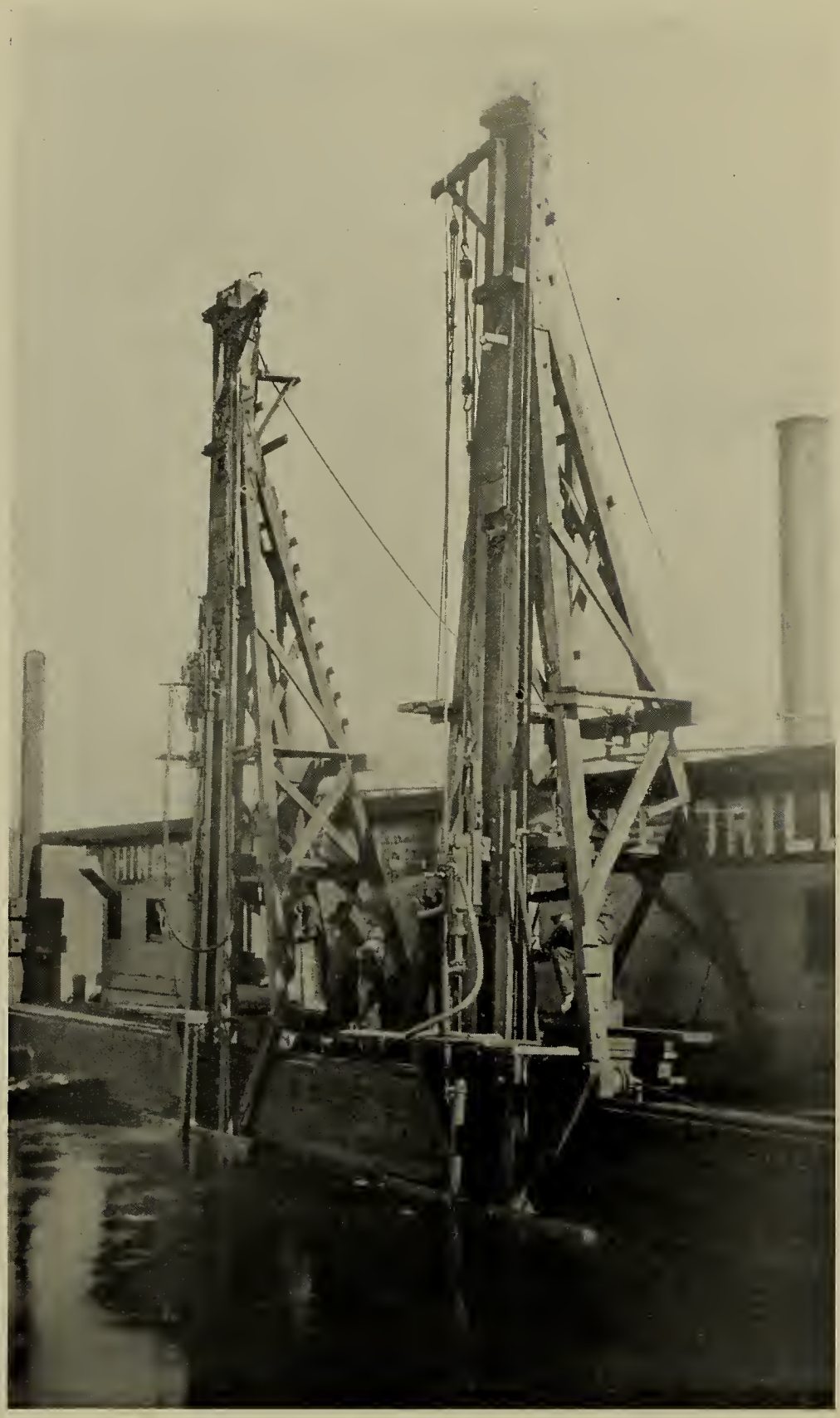
Rock—Cost.—The rock is granitic in character. It is not in a solid mass. Strata of hard rock, from 1″ to 3′ thick, the thinner sometimes of pure quartz and the thicker of gneiss, alternate with strata of disintegrated rock resembling dark granite. In 1892 the cost per cubic yard, measured on lighters by displacement, of drilling and blasting the hard rock was $1.37, and of dredging it afterward under contract $1.10—a total of $2.47.

Floating Platform.—The Dock Department of New York City made use of a floating drill-platform for rock excavation in the harbor. The platform was 33½′ × 22′ × 6′, deep enough to

PLATE IV.



MODEL OF DRILL PLATFORM. IMPROVEMENT OF JAMES RIVER, VA.



DRILL SCOW AT WORK, IMPROVEMENT OF HARBOR OF OSWEGO, N. Y., 1893
From photograph by Wm. Pierson Judson, Asst. Engr.

have excess of buoyancy over that required for the load of drills and laborers. At each corner a cable attached to a 3000-lb. anchor ran over a winch. By heaving on the cables the platform was drawn down until it stood rigid under wave and current action. The drills were then operated through it in the usual manner. A full description of the platform and mode of operation is given in the Trans. Am. Soc. C. E., vol. xxxii, p. 237.

Drill-scow—Work in Oswego Harbor.—In a report on the improvement of Oswego Harbor is the following description of rock excavation, which is here given as an example of a method which has proved most successful. It was first used on Lake Erie in 1872 by Mr. C. F. Dunbar, of Buffalo, N. Y., and has been gradually elaborated to its present efficiency. The river at Oswego was being deepened to 15′ at extreme low water.

"The rock which forms the river-bed and underlies the whole region is a graywacke sandstone of several hundred feet depth, with nearly horizontal strata of 1 to 2 or more feet in thickness each, the upper layers having seams in which the drills often jam. The hardness of the rock varies greatly, a drill sometimes cutting 10 or more feet and then wearing dull while cutting one foot.

"The drill plant consists of a heavily built scow 82′ long, 26′ wide, 6½′ sides, and drawing 2½′. On deck is a house 72′ long, 14′ wide, and 10½′ high, containing the boiler, spud-and-capstan engine. steam-pump, and blacksmith shop, with hand-power blower."

"Upon the deck of this scow, occupying an 8-foot space at the side of the house, is a track of 6½′ gauge, upon which travel two drill-frames, each mounted on a separate truck. Each truck is moved at will by two men, each working a five-foot lever and ratchet, which engages a 10″ pinion upon each shaft of the truck-wheels. . . .

"Each drill-frame carries a No. 5 Ingersoll drill of 5″ cylinder and 7″ stroke, whose only peculiarity is that it is attached to a 6″ piston of a 12′ hydraulic cylinder set vertically in the top of the drill-frame. . . . The hydraulic hoists are useful in easily and quickly raising and lowering the heavy drills, but their special value appears when the drill becomes jammed in the hole by encountering a seam or by a piece of gravel. . . .

"The hydraulic hoists are operated by a duplex Blake pump of 7½″ steam-cylinder, 4½″ water-cylinder, and 10″ stroke, with a 5″ suction and 2″ discharge, worked by 80 lbs. of steam-pressure.

"The water-pressure is supplied separately to each drill-frame by a set of 2″ pipes, which are each fitted with three loose elbow-joints, and which travel over the roof of the house to permit the free motion of the drill-frames along the track. The steam-pipes which supply the drills are fitted in the same manner. . . .

"The steam-pressure which works the pump is supplied by an estimated 30 horse-power tubular boiler 12′ long, 52″ diameter, with seventy-two 2¼″ flues, 7′ 4″ long, and with 20 square feet of grate surface, and limited to 85 lbs. pressure.

"Two crews of six men each are employed, and in addition are a blacksmith and helper, who work with the day crew only and point the drills for both crews. . . .

"The method of operation of the drill-boat is as follows:

"The drill-boat is hauled into the desired position, lengthwise of the river, by her steam capstan or by the tug, and anchored by four spuds, of which there is one at each corner. The two spuds on the side with the drills are 14″ × 14″ oak, and the other two are 12″ × 12″ oak. All are worked with steam hoists.

"Being in position, one drill is then moved to the up-stream end of the boat, and the other midway.

"The casing-pipe of 4½″ wrought-iron tube is then lowered on to the bottom, and forced down into and probably through the loose gravel, of which more or less covers the rock.

"This casing-pipe, within which the drill is to work, stands 2 to 4 feet above the water, and has a double T about two feet above its bottom to allow the escape of the drill chips. It remains in this position until the hole has been completed and the cartridge placed ready for firing.

"The openings in the casing-pipe are generally effective in allow-

ing the action of the water to clear the drill-hole. But whenever it is necessary to wash out the drill-hole, there is provided a piece of pipe, 24′ long and $\frac{1}{2}$″ bore, which can be put down the casing-pipe to the bottom of the drill-hole, and connected to the force-pump by a heavy 1″ hose. . . .

"The drill is 26′ long, the upper 14′ being $1\frac{1}{4}$″ -round machine steel; the next 10′, $1\frac{3}{4}$″-round machine steel; and the lower 2′ 2″, octagon steel, upon which the blacksmith forges a $3\frac{1}{4}$″ diamond-point square cross, tempered in a saturated solution of equal parts by bulk of sal-ammoniac, salt, and alum.

"To get this drill in position, it is first hoisted by a hand tackle, which hangs for the purpose from the head of the drill-frame and is lowered by hand into the casing-pipe. The discharge from the hydraulic cylinder is then opened, and the drill-cylinder is lowered until its chocks rest upon the head of the drill, where it is clamped. The steam is then turned on and the drill set at work. . . . The hydraulic hoist is kept in constant use to raise and lower the drill as needed. The holes are drilled 2′ to 3′ below the grade, and are spaced 5′ apart upon lines which are 5′ apart. Occasionally the holes are $2\frac{1}{2}$′ apart when the rock requires it. The various depths of face require the holes to vary from 4′ to 7′, the average of 1000 holes being $5\frac{1}{4}$′.

"If the rock is fairly clean and free from seams the $5\frac{1}{4}$′ may be drilled in 30 minutes. Otherwise it may require 3 hours. The average of 1000 holes is $5\frac{1}{4}$′ per hour. The maximum rate at which the drill has penetrated is 1′ in four minutes.

"The drill is withdrawn to be sharpened as often as results indicate this to be necessary, but it is not repointed until the arms of the cross wear off, so that the hole cut is $2\frac{1}{2}$″ diameter. Then it is upset and reforged to cut $3\frac{1}{4}$″. About 12 drills per 22 hours are thus repointed, using about 20′, or 240 lbs., of 2″ octagon steel for about 6000′ of drill-holes. The hole having been drilled, say 5′ deep, to 2′ to 4′ below grade, the drill is freed from its clamps and hoisted again to the head of the drill-frame. Meantime the drill-master gets from the magazine, in a small boat moored alongside, a $2\frac{3}{4}$-lb. cartridge of 75 per cent dynamite, which is 2″ in diameter and 18″ long, and embeds in its centre a Laflin & Rand fulminate-exploder, having 4′ wires, with which he takes a clove hitch around the middle of the cartridge. The amount of dynamite used in each hole varies from 2 lbs. upwards. To the end of these wires he twists the ends of the leading wires which run to the reel. There is a separate reel of leading wire with a separate Laflin & Rand magneto-electric machine beside it, for each drill. The cartridge is then placed in the iron loading-pipe, which always hangs by a small tackle from each drill-frame. . . . The loading-pipe is then lowered by the drill-man steadily down the casing-pipe, the drill-master holding the wires and easing them down.

"When the bottom of the hole is reached the drill-master unclamps the plunger which works within the loading-pipe, and forces it down steadily upon the cartridge, while the drill-man slowly hoists the loading-pipe until it is free from the cartridge, which is thus left at the bottom of the drill-hole. The loading-pipe and rod are then withdrawn, leaving the wires leading up and out of the top of the casing-pipe. . . . To this casing-pipe a chain from the hydraulic hoist is then hooked, and the casing-pipe is raised 4′ or 5′ from the bottom."

The charge is then fired. "No attempt is made to couple two or more holes together nor to remove the drill-boat from over the blast. The amount of dynamite used in each hole varies from 2 to 6 lbs., $2\frac{3}{4}$ lbs. being the usual quantity. . . ."

The lower end of the loading pipe, "which receives the cartridge, is a $2\frac{1}{8}$″ pipe, 3′ long, with a $\frac{3}{8}$″ slot for its full length. The edges of the pipe at the sides of the slot are smooth and rounded to avoid injury to the insulation of the fuse wires. The upper end of this slotted pipe joins a pipe of 1″ bore, 22′ in length, within which works a plunger-rod $\frac{3}{4}$″ diameter and 27′ long, having a 2″ head at its lower end to rest upon the cartridge. . . . A clamp at the upper end of the 1″ pipe holds the plunger-rod until wanted. The

slot described receives the wires and permits them to hold the cartridge in place in the loading pipe until it is forced out by the plunger, when the wires slide along the slot until released. . . .

"The entire operation from the time of stopping the drill to the explosion requires three minutes in ordinary work and may be done in one and one half minutes. . . ." The drill can be shifted 5′ to its new position in two minutes.

. . . . . .

Generally the rock is broken into pieces of 1 to 2 cu. ft. each, which are removed by dredging, a cubic yard or more being brought up in each dipper load. "Occasionally a piece of 1 or 2 cu. yds. is brought up, which is too large to drop through the dipper. In such cases the dipper is rested upon the dump-scow while a hole is drilled in the rock with a hand-drill; 6 to 8 ounces of dynamite are then packed into the hole, which is plugged with a handful of cotton waste. The explosion breaks the rock without injury to the dipper or scow. . . .

Cost.—"It is not known what the cost to the contractor of doing this rock excavation may be, but a close observation of the methods described enables an estimate to be made of what its actual cost should be under all existing conditions. For this estimate 1000 cu. yds. of rock above grade-line are taken as a basis. For this there must be drilled 1650 holes, aggregating 8660 linear feet. This will require 33 days of 22 hours each, costing:

For 33 days' wages of drill crews, at $31	$1,023.00
" 4,000 lbs. of 75% dynamite, at 17 cents	680.00
" 1,800 platinum-fuze electric exploders, at 3 cents	54.00
" 49½ net tons, bituminous coal, at $3	148.50
" 42⅛ gals. cylinder-oil for drills, etc., at 30 cents	12.70
" 55 gals. kerosene-oil for lanterns, at 12 cents	6.60
" 260 lbs. octagon steel for drill bits, at 15 cents	39.00
" 55 lbs. machine steel for drill bars, at 4 cents	2.20
" general machine-shop repair-bill, at $1 per day	33.00
Total	$1,999.00

"The result of this expenditure would be to break up not only 1000 cu. yds. of rock above grade, but probably also an equal amount below grade. In dredging this broken rock the dredge must work deliberately because of the many irregularities of the rock surface, . . . and much rock must be removed which comes from below grade and is not paid for.

"Ten days' work of the dredge and tug at ten hours per day, actually costing the contractor $500, is a fair estimate for the dredging, making, with the other expenses before itemized, an estimated total cost of $2499 for 1000 cu. yds. of rock from above the grade-line drilled, blasted, and removed." (Rep. of Wm. Pierson Judson, Asst. Engr., Rep. C. of E. 1893, Pt. 4, p. 3161.)

The cost of excavating very hard limestone with a drill-scow at Rock Island rapids in 1892, including charge for use and deterioration of plant, was $3.08 per cu. yd. solid rock, for blasting only, and $4.73 for blasting and removing the rock by dredging.

Drill-scow "Gen. Newton."—The strong currents and the great amount of passing commerce in New York Harbor rendered necessary a special device for rock excavation there, which should be strong enough to inflict rather than to receive injury from collisions while at work, and which would hold the drills firmly in position, no matter how strong the currents. It consists of a very heavy drill-scow, having a large well through its centre through which is lowered a heavy iron dome, open bottom and top, and arranged so as to rest firmly and evenly on an irregular rock bottom. While drilling is in progress the dome is entirely detached from the scow. It contains the guides for the drills, which are attached by flexible connections, adjustable in length, to the drill-engine pistons on the scow.

This apparatus has been most successful for the duty for which it was designed, but the plant is too expensive for use under ordinary conditions. A detailed description of the plant and methods of work can be found in the "Catalogue of the War Department Exhibit, World's Columbian Exposition."

SEA AND LAKE SHORE PROTECTION WORKS.

Sea-walls.—Sea-walls vary in construction, according to their site, exposure, and object. Masonry walls with smooth faces, nearly vertical, with the base below the low water-level, are used where it is desirable that there shall be no beach to catch floating objects, or where deep-draught shipping is to be brought close alongside. Where the object is simply to protect a beach from scouring away, inclined rubble-walls, or simply strong pavements laid on the slope of the beach are generally cheaper.

Cut-stone Sea-wall on Concrete Foundation. — The sea-wall around Governor's Island, New York Harbor, is a good example of a wall built to protect the island and to prevent the deposit of drift. The wall is exposed to the full force of the waves from New York Bay and to those caused by large steamers passing at high speed. The mean rise of tide is 4.4′. The following description is taken from the specifications. The foundation is concrete. This is 6′ wide on the top, which is 0.4′ above mean low water. The thickness varies from 1′ to 6′. The concrete is composed of 1 part best Portland cement, 2 of sand, and 6 of broken stone, gauge $1\frac{1}{2}''$. It was deposited from skips, where laid below water. The trench for the foundation was lined with sand-tight sheet-piling strengthened by round piles driven outside the foundation. The top of the concrete was protected during construction.

The masonry superstructure is 10′ high, 4′ wide at bottom, and 3′ at top. The toe of the wall is 2′ inside the edge of the foundation. The face has a batter of 1′. The back is vertical. The stone used is blue dolomite. The stones are in courses, and are alternately headers and stretchers, breaking joints in adjacent courses with a lap not less than 6″. The headers extend entirely through the wall, and the space behind the stretchers is filled in with rubble masonry or concrete. Stretchers are not less than 4′ long with a top width uniformly 3″ greater than the rise. Headers have a length equal to the thickness of the wall and a width 3″ greater than the rise. The stones have rock face, the projections nowhere being greater than 3″. The edges are pitched, without draught-lines. The joints are $\frac{3}{8}''$ thick. The mortar used is 1 part best Portland cement and 2 of sand. Apertures 6″ wide and 15″ high were left at given points for surface drains. Where required, adjacent stones are joined by wrought-iron cramps of $1'' \times \frac{1}{2}''$ bar iron, 12″ long, with L's 3″ long, set with sulphur or other approved packing. Coping-stones are connected by wrought-iron dowels $2\frac{1}{2}''$ diameter and 6″ long, packed in the same manner. Miscellaneous filling, free from all vegetable or animal matter, was filled behind the wall in 1′ layers and rammed, to 1′ from the top. Above this plane the filling was of loam.

Cost.—The contract price for this work was: Concrete foundation, $11 per cubic yard; masonry wall, $19 per lineal foot; embankment, 29 cents per cubic yard; iron-work, 23 cents per lb.

Some of the sea-walls in Boston Harbor are of a similar character, of granite, and are even more strongly built. Others are simply heavy riprap, covering the slope of the beach for a safe distance from the high-water line.

Heavy Riprap Sea-wall.—The sea-wall built to protect Sandy Hook from erosion consists of a continuous mound of riprap, in pieces varying in weight from 300 lbs. to 3 tons, extending along the beach just below the high-water line. The crest is about 5′ above the level of the adjacent beach, and the wall has a cross-section of about 50 square feet. At intervals along the back and front of the wall are short spurs, to stop racing waves. As was expected, the foundation was undermined by wave action and the wall sank, in places, as much as 5′. It was rebuilt to the original height, and the limit of settlement was found to have been attained. The length of the wall is 2500 feet, and the cost, including repairs of settlements, was $7.50 per lineal foot.

Chicago Shore Protection.—The Lake front of Lincoln Park at Chicago is being protected by a work comprising a pile-and-stone bulkhead and a paved beach, known as "Marshall's Shore Protection." The latest Lake-shore drive-protection work is constructed as follows:

48′ from the outer face of the driveway parapet wall is the outer face of the bulkhead, placed in water about 12′ deep. This was constructed as follows: Two lines of white-oak or Norway-pine piles were driven parallel to the line of the beach. The rows were 16′ apart and the piles in each row 4′ apart, between centres. The penetration of the outside row into the Lake bottom was required to be 13′ and of the inner row 10′. The tops of the piles were sawed off evenly at the mean Lake water-level. An oak wale, 12″ deep, made of two planks of 4″ × 12″ oak, breaking joints, was then bolted on the land side of the outer row of piles, with the top edge flush with the tops of the piles, and fastened to each pile with $1\frac{1}{8}$″ screw-bolts, with wrought washers under heads and nuts. The nuts were placed on the land side, and countersunk flush with the face of the wale, and the screw heads upset and riveted fast after the nuts were drawn home. An 8″ × 12″ oak wale was similarly placed against the outside face of the inner row and similarly fastened. A line of Wakefield sheet-piling, of 3″ Norway pine or 2″ oak plank, was then driven inside of and in close contact with the outside waling strip; another wale, of 4″ × 12″ oak, placed inside the tops of the sheet-piles, and the two wales and the sheet-piles tied together with 1″ screw-bolts, one on each side of and one foot from each joint of the front and rear wales, with intermediate bolts where the intervals were more than 6′ long.

A line of common sheet-piling, 4″ thick, was then driven outside the waling strip of the inner row of piles and in close contact with it, and spiked with 8″ wrought spikes to this wale. This line was further secured by a 4″ × 12″ wale outside its top, fastened by $\frac{5}{8}$″ screw-bolts, through both wales and sheet-piles, and placed as in the outer line.

The two rows of piles were then tied together with $1\frac{1}{4}$″ iron tie-rods, enlarged at the screw-ends to $1\frac{1}{2}$″, and with heads and nuts resting on heavy wrought washers. These ties ran through the two lines of wales, near each round pile. The heads were placed on the outside and the screw ends were upset and riveted like the bolts.

This bulkhead was then filled with stone to within two feet of the top, in sizes which varied from small gravel to a weight of 200 lbs., 40 per cent of the volume being less than 5 lbs. in weight. All of the voids were carefully filled with sand, screenings, and gravel, and the bulkhead made thoroughly sand-tight.

The beach was then filled in where necessary, and graded so that when paved, the plane of the top of the pavement should have a slope of about one on eight, from the base of the driveway parapet to the outer face of the bulkhead. After having been thoroughly tamped and settled, this was then paved with granite blocks, placed on a concrete bed, 6″ thick for 10′ back from the back of the bulkhead and for 10′ in front of the parapet wall, and 4″ thick through the middle. The concrete was composed of 1 part cement, 2 parts sand, and $4\frac{1}{2}$ parts crushed limestone, not exceeding 1″ in largest dimensions. The paving-blocks were 8″ deep over the outer and inner thirds of the beach and 6″ to 7″ deep over the middle. They were set with mortar of 1 part cement to 2 sand, and the joints were carefully filled. The concrete was laid dry, and after the stone had been placed it was wet slightly by sprinkling through the joints of the pavement. Then these joints were filled carefully with the mortar, also dry, swept in with a wire broom, and slightly sprinkled with water. The remaining moisture necessary for the proper hardening of the concrete and mortar was derived by capillary attraction from the wet sand of the beach beneath, and from the waves rolling over the beach. This method gave perfectly satisfactory results. After the filling of the bulkhead had been thoroughly compacted and the voids filled, the pavement was continued across the bulkhead with limestone blocks, 12″ to 18″ deep, or with the lighter paving.

Landward, the paved beach is completed with a rubble-stone retaining-wall, $3\frac{1}{2}$′ thick at the base, which is at least 4′ below the top of the pavement. The wall was laid up in mortar of one part natural cement and two parts sand. Landward of the wall is a promenade paved with artificial stone, connected with the beach and

the roadway by steps of artificial stone. The work was constructed in 300′ sections.

The entire beach protection is sand-tight, and the completed portion has resisted the storms of three winters without the necessity for repairs. This shore protection, including 12′ of filling under the pavement, cost $70 per lineal foot. When the breakwater is located in water 10′ deep the bulkhead wall and beach cost about $56 per lineal foot. The combination is protected by letters patent.

New York Bulkhead.—The bulkhead-line wall of New York City is an excellent example of good construction. It is a high wall on a soft foundation, and is subjected to a heavy pressure on its back. A description of this work, carried on by the Department of Docks, can be found in vol. xxvi, *Engineering Record.*

Light Concrete Sea-wall.—A light concrete sea-wall was constructed at St. Augustine, Florida, in the following manner: The bottom of the wall was located at the level of mean low water and the trench for the foundations, 18″ deep, was excavated in very soft quicksand. To make the trench and place the foundation, strong frames 18″ deep, 6′ long, and the width of the foundation (about 4′) were built of 2″ lumber. A frame was placed over its site, weighted, the sand and water were excavated from its interior, and at the same time a stream of water from a force-pump was kept playing on the exterior. By this means the frame was gradually sunk to the proper depth, and the trench cleared. A layer of concrete mixed without water was promptly placed in the bottom of the trench, and the remainder of the concrete for the foundation was rammed on it as rapidly as possible, care being taken to keep the proportion of water low enough to allow for the water seeping up through the bottom layer.

On this foundation the wall was built to full height in sections 6′ long. The boxing for the concrete was made in panels, the proper size for the section. The end of the wall already built formed the panel at one end. The panel at the open end was propped into place, and the side panels placed and tied together with heavy wire, drawn taut between them and fastened on the outside of the panel. In this frame the section was built to full height, when the end panel was removed and the next section built. The side panels were left in place until the concrete had set, when they were taken off, and the ends of the wires, which had been built into the concrete, were cut off flush with the faces of the wall. Weep-holes for drainage were made at intervals by building pipe into the wall at the proper height.

The total height of the wall is 9′ and its length 292.5′. The cost was $7.55 per lineal foot.

Dry-rubble Sea-walls.—The retaining-walls at the harbor of Wood's Holl, Mass., are of dry rubble, resting on a foundation of riprap. The situation is well sheltered, and the range of tide is about 2 feet.

A trench was dredged and filled with granite riprap laid carefully by hand by divers. The wall is 3′ wide on top, 6′ above mean low water, and the base 7′ wide at the depth of 6′ below mean low water. The batter is 12 on 1 on the face, and 4 on 1 on the back, in offsets. The stones are of best quality granite-rubble wall-stones, laid on their quarry-beds, the top and bottom courses being of full-length headers, laid close, each course of uniform thickness, not less than 18″. Not less than one-fifth of the stones in the face of the remaining courses are through-headers. The intermediate courses are from 12″ to 2′ thick. No stone in any part of the wall has less width than thickness, nor more length than 5 times the thickness. No part of any face-joint is more than 3″ thick. Each stone breaks joints by at least 6″.

The necessary dredging was paid for by the cubic yard, measured in scows; the riprap, in place in foundation, by the ton of 2240 lbs., measured by the displacement of vessels; the stonework of the walls by the cubic yard in place.

The contract prices were as follows: Dredging, $1.50 per cubic yard; riprap, $3 per ton; walls, $10.90 per cubic yard.

Groins.—Another mode of shore protection is by the use of groins, or spur jetties, built at right angles to the beach, from above the high-water line to any desired length beyond the low-water line. For protection against the sea these are usually of riprap or masonry, with or without brush-mattress foundations. When composed of riprap the construction methods are similar to those for riprap jetties, which will be described later. The following is an example of successful construction, in which concrete blocks were used, in the absence of heavy stone at reasonable prices.

Concrete Groin on Rubble-and-brush Foundation.—Groin at St. Augustine, Florida.—This is one of a series built to stop the erosion of the beach on the open Atlantic coast opposite the city. The shoal water of the beach extended for some width off the site and afforded some protection against the heaviest Atlantic waves. The range of tide is from 4′ to 6′. The groins consist of a foundation of brush in fascines, ballasted with riprap and capped with concrete blocks. The groins extend from shoreward of the highest level of storm action to points beyond the lowest water-line.

Groin No. 5 is 465′ long. From the inner end for 79′ the concrete blocks have a rectangular cross-section, 4′ wide and 2′ thick, with the tops 8.9′ above mean low-water level. For the next 135′ they are 3′ thick, 6′ wide at base, and 2′ wide at crest, with side slopes of 1 on 1, stopping at a height of 1′ above the base. The crest of this portion of the groin slopes from reference 8.9′ to reference 5.9′ above mean low water. For the remainder of the groin the concrete blocks have the same top width and side slopes as the preceding section, but the thickness is 4′ and the width at base 8′. The crest of this portion slopes from reference 5.9′ to reference 5.3′, above mean low water. The blocks throughout the entire length are 5′ long. The fascines of the foundation are of brush, choked to 9″ diameter, and long enough to provide an apron along each side of the groin. The fascines are laid at right angles to the axis of the groin. Where the water was shoal and the wave-action slight, they were placed separately and ballasted with rock. Where the wave-action and the currents were strong they were fastened together with $\frac{1}{2}$″ manilla rope at as many places as seemed necessary, and then sunk and ballasted with heavy riprap. Along the axis of the groin the rock was piled to the level of the base of the blocks, for a width slightly greater than the width of base.

Construction Methods.—The concrete blocks were made in place, in strong boxes of unplaned lumber, with the joints as tight as possible. When swelled by the water they were practically water-tight. To protect the concrete while setting the boxes had to be provided with bottoms where the wave-action was strong. The ends of the boxes were made at once of full section and were held in place by the bottoms and by the vertical parts of the sides. The boxes were placed at low water, the riprap beneath them having been levelled and chinked. They were loaded with stone and left to settte through one tide. At the succeeding low water the concrete was placed in them and rammed in the usual manner, the sloping portions of the box sides being placed and nailed on as soon as the rammed layers had been built high enough. When the form was full, the top was tightly nailed on. Attention was paid to getting a smooth face on the sides and top before the boxing was placed. Although at times subjected to heavy wave-action within an hour or two after being placed, none of the concrete was injured in any box which held together until the concrete had time to attain a tensile strength of more than 30 lbs. per square inch, which strength was attained generally in 48 hours after placing. The boxing was left and was gradually broken up by wave-action, without injury to the groin.

The following tables show the cost of this work. When Saylor's American Portland cement was used the proportions for the concrete were: 1 cement, 3 sand, and 5 coquina gravel (clean, fine, broken shell); for the end blocks with the same cement, 1 cement, 2 sand, and 4 coquina gravel. With Sphinx or Anchor brand of cement, the proportions were 1 cement, 4 sand, and $6\frac{1}{2}$ coquina gravel.

Table of Cost.

Wages of carpenter, 28 cents per hour.
Wages of laborer, 15 cents per hour.
Cost of rock, displacement measurement, $2.70 per ton 2000 lbs.
Cost cement, per barrel $2.80.
Cost of making fascines, $3.14 per 100 feet,
Cost of lumber, per M, B.M., $15.50.

Cost of Concrete per cubic yard.

Materials.		Labor.	
Cement	$3.44	Boxing	$0.82
Shell and sand	.75	Mixing and ramming	1.55
Lumber	.51	Handling cement	.11
Nails	.04	Superintendence	.35
		Transportation	.15
Grand total	$7.72		

The concrete was all mixed by hand, using shovels alone. The materials for the batch were turned over three times dry, water was then added, and four additional turnings given. The concrete was wheeled in barrows to the boxes, using the completed portions of the groin as a runway. Seventy-five barrow loads of concrete materials, mixed, made 80 cubic feet of rammed concrete. A good distribution of the working party was: 1 man measuring materials, filling barrows, etc.; 4 men mixing, two at a time; 1 man wheeling (when the distance did not exceed 200 feet) and 2 men ramming. An additional man could be kept busy wheeling for every 250 feet additional between the mixing platform and the point of deposit of the concrete.

The total cost of all tools used in mixing, wheeling, ramming, and covering concrete was about $30.00.

Capacity of Cement Barrels.—The capacity of Norton's Rosendale-cement barrel was 3.4 cubic feet; Portland-cement barrel, "Anchor" brand, 3.35 cubic feet; "Sphinx" brand, 3.25 cubic feet.

Measured loose in quantities of 2 cubic feet at a time, a barrel of Norton's Rosendale gave 4.37 cubic feet of loose cement; a barrel of "Anchor" Portland, 3.65 cubic feet; of "Sphinx" Portland, 3.71 cubic feet. A sack of lime of Teil gave 2.1 cubic feet.

Weight of Concrete.—One cubic foot of Portland concrete of the given proportions weighed 143.2 lbs. when newly made, and 137 lbs. when one month old. One cubic foot of Norton's Rosendale concrete weighed 133.3 lbs. and 131 lbs. at like ages. The proportions for the Rosendale concrete were 1 cement, 1 sand, $2\frac{2}{3}$ coquina gravel. (Rep. C. of E. 1890, Pt. 2, p. 1575; and 1891, Pt. 2, p. 1631.)

Sand-catches.—These are works intended to stop the drift of sand on an open beach. They consist of a barrier of any description so arranged as to cause as few wind eddies as possible.

Inclined Fence.—One form is an inclined fence of 1″ boards nailed to and supported by triangular frames of 2″ × 12″ × 14′ plank, standing at right angles to the line of the fence and spaced about 7′ apart. The boards are placed with 1″ to 2″ intervals between them. The frame is weighted or staked down, and the open side of the catch faces the direction of the controlling gales. Such a fence can be made for $1.10 per running foot. The intervals between the boards are left with the design of decreasing the wind eddies.

Post-and-board Fence.—An upright post-and-board fence has also been effective. Where it is desired to raise the sand rapidly to some height with this form, it is advisable to place only one or two bottom boards on at first, and to nail on others as the sand accumulates, care being taken to keep an interval of about 1″ between the successive boards.

Newburyport, Mass., Pile-and-brush Sand-catch.—This is of the type which is probably the most effective. It consists of two parallel rows of spruce posts, sunk 4′ into the sand. These posts are 5′ apart in both directions, and are of 6″ × 6″ lumber, 9′ long. They are connected and braced at top and bottom by 3″ × 2″ spruce strips, in both horizontal directions, securely spiked on with two 40d. spikes at each intersection. Twenty feet apart, on alternate sides of the sand-catch, are spurs, 10′ long, built in the same manner as the sand-catch. The entire sand-catch is filled with freshly cut brush, averaging 5′ long and 1″ at the butt, loaded with bowlders or chips, of an

average weight of 50 lbs., to the amount of 500 lbs. to the running foot of structure. The contract price was, in 1886, $2.67 per running foot.

Where stone is not available the brush can be held in place between the posts with wire.

These are structures designed to protect a harbor from wave action. In the sea, where the teredo is found, they are built of stone. If the bottom is sufficiently hard, the stone is placed directly on it. If too soft or too easily scoured, brush mattress foundations are used.

BREAKWATERS—SEA.

The following description of the breakwater now under construction at the Point Judith Harbor of Refuge, taken from the specifications for the work, will serve as an example of a riprap breakwater on a reasonably hard bottom:

Breakwater, Point Judith Harbor of Refuge.—The location of the breakwater is very much exposed to easterly, southerly, and westerly storms. The nearest harbors are those of Newport, about 14 miles to the northeast; Block Island, about 12 miles to the south; and Stonington, about 23 miles west. The mean rise and fall of the tide is about 3′. The breakwater is to be built in water from 12′ to 32′ deep. The finished breakwater is to have the following profile: Reference of top, 10′ above mean low water; width of top, 20′; inside slope, 1 on 1; outside slope, 1 on 2 down to a depth of 12′ below mean low water, and 1 on 1 for the remaining distance to the ocean bottom. If these slopes are cut down by the force of the waves, extra stone is to be added on the top whenever and wherever necessary to restore the original top width of 20′.

The core of the breakwater (or that part which is more than 10′ inside the side surfaces) is to be composed of stone of any sizes which weigh over 200 lbs. apiece, and is to be built up into the form of a mound having an approximately level top about 12′ below water-level and about 60′ wide, and having inner slopes of 1 on 1 and outer slopes of about 3 on 4. As fast as the core is built, it is to be covered on the sides and top with a facing of large stones of sizes which weigh at least 3 tons apiece; and these large stones are to be added until this facing is at least 10′ thick over the top and sides of the core, and also until the profile of its outer surfaces becomes that of the finished breakwater, as given above. The construction of these two parts of the breakwater should be so carried on that the core should not at any time extend more than 100′ beyond the facing. The stones forming the top surface of the facing must be laid so as to form a reasonably even, level, and close surface. Where necessary, this top surface of the breakwater will be chinked up with smaller stones.

The core-stone must be of durable quality, not liable to disintegration in sea-water; it should be at least as hard as hard-burned brick, and should weigh dry at least 140 lbs. per cubic foot. The facing-stone must be granite or gneiss; should be at least as heavy as the core-stone; and should be quarry-stone, of angular shapes (not of rounded shapes, neither parts of bowlders nor resembling bowlders), each piece with its least dimension not smaller than one-quarter nor greater than two-thirds of its greatest dimension. All the stones must be of sizes as described in the preceding paragraph; and in quality, size, and shape must be satisfactory to the engineer in charge.

The stone is measured by water-displacement of vessels, and is paid for in place in tons of 2000 lbs.

The contract price for this work, under the contract dated March 15, 1893, was 1.27\frac{2}{3}$ per ton of 2000 lbs. for both classes of stone.

Delaware Breakwater.—A rubble mound 1390′ long is now under construction, to connect the two detached portions of this breakwater—the Breakwater proper and the "Ice-breaker." The completed mound is to have a top width of 20′, 14′ above the plane of mean low water, with slopes above that plane of about 1 on 0.7, covered with heavy stone, laid in position. Below the plane of mean low water the slopes are to be those formed by the action of the sea. The mean range of tide is 5′. The depth of water is about 18′ at mean low water.

In 1884–5 a foundation mattress of brush, 2′ thick and 90′

wide, was laid across the gap between the detached portions, in sections of 16′ × 30′, and anchored with one-man stone. On this foundation, up to June 30, 1893, 154,481 tons (2240 lbs.) of stone have been placed, almost all under specifications which called for blocks of one half ton and upward, with a portion, not exceeding 5 per cent, in pieces weighing between 800 lbs. and one half ton. This work was done ,under different appropriations, between 1884 and 1893. In October, 1893, the mound had been raised to the level of mean low water for the entire distance. In June, 1892, the average slopes were as follows: Above a plane 8′ to 10′ below mean low water, 1 on 0.6, the exterior slope being somewhat the steeper; below the 10′ plane, the stone placed in 1891 had a slope of about 2 on 3, that placed in 1892 of about 1 on 1. These were storm-developed slopes. In 1893 the entire work was found to have settled about one foot.

Weight and Volume of Stone.—From careful measurements of the volume of the stone as piled on the barges, ready for deposit, it was found that the weight of the random stone (granite) was 1.15 gross tons per cubic yard. Careful surveys of the mound showed that it contained 1.17 gross tons per cubic yard, as compacted by wave-action. The weight of a solid cubic yard of the stone used is two gross tons. To allow for the compacting of the mound under the wave-action, and for stone badly placed or knocked off, the estimate of the amount of stone to be required is based on an assumed amount of 1.25 gross tons to the cubic yard. For this kind of stone, with the assumption usual in railroad work (that one cubic yard of solid rock will make 1.7 cubic yards of settled embankment), the amount of stone actually to be required, without allowance for loss, will be 1.18 gross tons per cubic yard.

New Work.—Under the specifications of October 18, 1894, the new work is to be carried on as follows: Commencing at the Ice-breaker, the present substructure is to be levelled to mean low water over that portion of the length upon which the superstructure is to be built. The stones for this levelling off, after such stones as now project are removed, shall weigh from 50 to 1000 lbs. each. The stones for deposit in depressions or cavities along the side slopes shall weigh from one half ton, upwards, with a portion, not exceeding five per cent, weighing from 800 lbs. to one half ton. The surface stones for the superstructure shall be large, weighing not less than 4 tons each, with the least dimension not less than one third the greatest, and of suitable shape to construct a random wall. The interior of the superstructure shall be filled with stones varying in weight from 50 to 1000 lbs., or less than 50 lbs. when necessary for filling interstices.

The contract prices for the stone placed from 1884 to 1892 varied from $1.99 to $3.20 per ton of 2240 lbs., in place in the breakwater, increasing in price as the mound was raised to the surface and the placing of the stone became more difficult. The contract prices under the last specifications are: for stone for levelling upper surface and filling depressions and cavities and the interior of the superstructure, $2.62 per ton of 2240 lbs.; for large stone placed in position in the superstructure, $2.62 per ton of 2240 lbs. The contractor is required to furnish at his own expense all necessary facilities for weighing and marking the stone. Should the work under the contract not be completed by Dec. 31, 1895, the price for all stone placed after that date is to be $1.74⅔ per ton of 2240 lbs.

Port Harford Breakwater, California.—The range of tide here is about 4′. The breakwater has its top 6′ above high water, and has a top thickness of 20′. The outer slope is 1 on 3, the inner slope 1 on 1. The sizes of stone used are: one fifth 50 lbs. to one ton; three fifths from 1 to 4 tons; one fifth 4 to 8 tons. All are to be in a fair assortment of sizes. A proper proportion of stone of the various sizes must be placed in position at one time. The stone of the second and third classes must be of angular shapes, with the least dimension not smaller than ¼ nor larger than ⅔ of the greatest dimension. The stone is paid for in tons of 2240 lbs., measured by displacement of vessels, or on scales. The contractor is allowed to deposit the stone from the vessels or from a tramway on the breakwater. The contract price for the stone under the contract of April 22, 1893, was $1.94 per ton, in place in the breakwater.

JETTIES AND DIKES—SEA.

Riprap Jetties—Jetties at Newburyport, Mass.—This work is situated on the east coast of Massachusetts. The entrance to the harbor is obstructed by a bar. The object of the jetties is to force the tidal currents to form a channel at least 17′ deep at mean low water across the bar. The tidal range at Newburyport is 7½′. Before work began the channel depth was about 7′. In 1893 it was 13′. The jetties are of riprap, deposited from vessels directly on the sand of the ocean bottom. The stone is required to be of the best quality as regards strength and durability, granite quarry-grout being preferred. It must be in blocks, of which one half shall weigh not less than two tons; the remainder must average two tons, with none less than ½ ton. The shape of the blocks must be as nearly cubical as possible, the smallest dimension being not less than one third the greatest. It is delivered and deposited so as to complete a definite length of jetty of the full cross-section. The top of the jetty is 15′ wide, and 12′ above mean low-water level. The outside slope is 1 on 2, the inside 1 on 1. The stone is paid for in place in the jetty by the ton of 2000 lbs., measured by the displacement of vessels. Under the contract of September 16, 1892, the price was $1.59 per ton.

Pile Dike at Canarsie Bay.—Canarsie Bay is one of the inlets of Jamaica Bay, on the south shore of Long Island. The position is sheltered from heavy seas, but is exposed to drift ice. The mean range of the tide is 4½′. The dike is built to protect the channel to Canarsie Landing. It is in water 4′ deep. It consists of two parallel rows of piles, 5′ apart from out to out, tied together with wooden and iron ties, and having the space between them filled with stone. The top of the dike is 2′ above mean high water. The piles are of oak, 26′ and 20′ long, not less than 12″ diameter at the larger end and 7″ at the smaller end. They are driven vertically, and so close together that when the heads are cut off the tops of adjacent piles are not more than 6″ apart. The heads of the 20′ piles are sawed off 2′ above mean high water. The 26′ piles are driven 50′ apart on the channel face of the dike, and in close rows at the outer and inner ends. They are cut off 6′ above high water. Two courses of yellow-pine timber, 6″ thick by 12″ deep, in lengths of not less than 24′, are securely bolted on the outside of each row of piles, so that the top of the upper course is flush with the top of the short piles. . . . The pieces of each course are connected with scarf-joints, 2′ long and with 4″ butts, accurately fitted, the scarf alternating in the upper and lower courses.

The two rows of piling are connected at intervals of 12′ by 12″ × 12″ square yellow-pine cross-ties, 6′ long, dovetailed into the waling-pieces, one half into each course, and accurately fitted. Two 1¼″-round iron tie-rods, with head and nut, each 2¼″ × 1½″, and screw-threads 7 to the inch, are placed between each pair of wooden ties, from outside to outside of the upper and lower waling-pieces, alternately, and passing through the centre of a pile on each side. Two iron washers, 4½″ × ¼″, are used for each tie. On the channel side the tie-heads are countersunk. The other ends are upset outside the nuts. The tie-rods are not placed within two feet of the scarfs. Each scarf-joint is fastened by two 12″ drift-bolts of ⅝″ iron, driven vertically. Between each pair of tie-rods, four 24″ drift-bolts of 1″ iron are driven through the two courses of waling-strips at an angle of about 85 degrees with the horizontal. The auger-holes for the drift-bolts were required to be $\frac{1}{16}$″ less in diameter than the bolts. The space between the two rows of piles is filled with stone of good quality, in pieces of from 25 to 200 lbs. in weight.

The contract price for this work was $9.87 per lineal foot. At points more exposed or where pressure of ice is expected, similar pile jetties are constructed with greater distance between the rows of piles, and at times are further strengthened by groups of oak fender-piles.

Riprap Jetties on Brush Foundations—Jetties along South Atlantic Coast.—All of these jetties are of riprap on a mattress foundation. The mattresses at Winyah Bay, St. John's River, and Sabine Pass are of brush fascines confined between grillages of poles. Those used at Charleston and Cumberland Sound are rafts of logs covered

with brush. The jetty at Winyah Bay is being built from a trestle. The remainder are built from scows.

Winyah Bay Jetty. Mattresses.—The range of tide at this work is 3.5′. The mattresses are built on inclined ways, on shore, the tops of the ways being lubricated to facilitate the launching of the completed mattress. A grillage of poles is first built of the dimensions of the mattress. The poles of each course are made continuous for the length of the corresponding dimension of the mattress by long splices. They are laid parallel in each course and 6′ apart, the poles of the two courses being at right angles and those of the upper course being placed so as to be at right angles to the jetty axis when in place in the jetty. The courses are then spiked together at the pole intersections. On this bottom grillage brush fascines, choked tightly to a diameter of 9″ and of the length of the mattress, are placed in close contact, parallel to the upper grillage-poles. On these fascines another layer of fascines is placed at right angles to the other, and with the fascines 6′ apart and opposite the middle of the panels of the lower grillage. A top grillage is then built, similar to the bottom one and with its panel corners directly over those of the bottom grillage, and the two grillages are drawn together and lashed securely by ½″ manilla ropes which pass through the mattress at the panel corners. The projecting ends of the poles are wired together. Range masts are placed on the mattress. When the mattress is placed, these are brought into the line of the jetty axis range. Towing beckets are also fastened to the mattress. The mattresses are towed as required to near the site of the jetty and then into position on the ebb tide. manœuvred into exact place by anchor-lines from scows fastened to the ends of the mattress, and sunk with rock.

Cost.—In this work the mattresses in 1892–93 were made about 9 miles up Winyah Bay. Each mattress contained about 650 sq. yds. 29 men and 6 mules collected materials and built 3055.55 sq. yds. of mattresses in one month.

In the Florida works the approximate cost of such a brush mattress 120′ × 75′ was as follows:

2 747 cu. yds. brush (labor at 15 cents per hour)	$57.96
Hauling to fascine rack, with cart and driver, at 25 cents per hour	110.59
Labor of making and handling 9660′ of fascines at 15 cents per hour	96.60
Cost 8906 feet poles, delivered at ways	60.00
600 lbs. 60-penny nails at $2.60 per 100 lbs	15.60
313 lbs. ½″ manilla rope, at 13⅜ cents per lb	41.86
426 lbs. No. 14 iron wire, at 4½ cents per lb	19.17
Labor of assembling mattress at 15 cents per hour	144.27
" " launching mattress at 15 cents per hour	21.50
" " sinking mattress at 15 cents per hour	27.00
Superintendence at $75 per month	18.75
Total	$613.30

or 61⅛ cents per square yard.

Trestle and Stone.—After the mattress work has been advanced about 1000′ a trestle is built along the jetty axis, the piles being driven through the mattress-foundation. The piles are from 42′ to 48′ long. The penetration varies from 8′ to 18′, with an average of 12′. The trestle-cap is placed 16′ above mean low water. The rip-rap is dumped from the trestle in such a manner that the cross-section of the completed jetty shall have a top 10′ wide, 6′ above mean low water, and side slopes of 1 on 2 on the outside and the natural slope for the stone on the inside. The stone must be of durable quality, not liable to disintegration in sea-water; at least as hard as hard-burned brick; must weigh at least 145 lbs. to the cubic foot; must be of quarry and not of rounded shape, and the greatest dimension must be not more than three times the least. The stones for the ballast of the mattress and for the hearting of the jetty are of sizes which range in weight from 50 to 400 lbs. The stones on the slopes for a horizontal distance of 4′ inward from the faces of the jetty must weigh from 1000 to 6000 lbs. each.

The stone is paid for by the ton of 2000 lbs., measured by the displacement of vessels, or by scales.

The prices under the contract of November 15, 1892, are: Mattresses, $1.05 per sq. yd. in place; small stone, $2.45 scow measure, or $2.48 scale measure, per ton of 2000 lbs., in place in jetty; large

stone, $2.70 scow measure, or $2.85 scale measure, per ton of 2000 lbs., in place in the jetty.

The works at Charleston and St. John's River are under contract for completion. They will therefore not be described.

Cumberland Sound Jetties.—The jetties here are designed to deepen the channel across the bar at the entrance to the sound between Amelia Island, Florida, and Cumberland Island, Georgia. The range of tide is 5.9′. The original depth at the entrance was between 11′ and 12′ at mean low water. In 1893 the available depth was 13′.

Mattresses.—A mattress similar to that described for Winyah Bay may be required under the specifications, but has never been used here. The mattress which has been used in the work consists of a raft of round logs not less than 12″ in average diameter and not less than 9″ in diameter at the small end, placed in close contact, side by side, held by transverse-pole binders spiked or bolted to them. The binders are smaller logs, not less than 5″ in diameter at the small end, and are placed not more than 8′ apart, those on the outside being close to the ends of the logs. On this raft is placed a layer of livewood brush, sufficient to give a thickness of 6″ in the finished work, secured by poles lashed to the binders of the raft. The mattresses are placed in the jetty with the logs at right angles to the jetty axis. Masts and towing beckets are placed on the mattress, as described for the Winyah Bay work, and the mattress is placed in the work in a similar manner. Two or more layers of mattresses and stone may be used in the jetty.

The requirements for the quality of the stone are like those of Winyah Bay. The sizes are to vary from 25 lbs. to 300 lbs. The general depth of stone to be placed on each mattress will vary from 6″ to 2′, at the option of the engineer in charge. The stone is deposited in the work from scows.

The lowest prices bid, September 29, 1894, were: for mattresses in the work, 57 cts. per square yard; for stone in the work, $2.00 per cubic yard, measured in compact piles on the scows, cars, or vessels bringing it to the work.

Sabine Pass, Texas.—The bar at this place is composed of soft mud. The jetties are built of riprap, resting on a brush foundation mattress, 100′ wide. In the new work light stone hearting is piled to the level of mean low water and covered on the top and sides with 2′ of granite riprap. The mound thus made is 20′ wide on top and has side slopes of 1 on $1\frac{1}{2}$. This is then capped with large blocks of granite, so as to make the crest of the jetty 8′ wide and 4′ above mean high water.

Mattresses and Stone.—The mattresses used in this work differ in construction from those described for the work at Winyah Bay only in having the bottom layer of fascines made tighter by placing fascines 6″ in diameter in the intervals between the tops of the 9″ fascines. The stone for ballast and hearting is required to be in suitably random sizes, which vary in weight from 20 lbs. to 600 lbs. It must be of a quality which will not deteriorate under the action of the weather and of salt water. It must be at least as hard as hard-burned brick, and must weigh, dry, not less than 130 lbs. to the cubic foot. The blocks must be angular, with the least dimension not less than $\frac{1}{3}$ the greatest. The granite riprap is to be of the same size as the hearting, and of a quality which will weigh, dry, not less than 160 lbs. to the cubic foot. The capping blocks of granite must be of the same quality as the riprap, must weigh 5 to 6 tons each, and in size must be approximately $2\frac{1}{2}' \times 4' \times 7\frac{1}{2}'$. The stone is paid for in place in the jetties, by the ton of 2240 lbs., determined by the displacement of scows evenly loaded, the weight of the sea-water at that point being assumed to be $63\frac{1}{2}$ lbs. per cubic foot. The prices under the contract dated October 24, 1892, are; for mattresses in the work, 95 cents per square yard; for hearting stone in the work, $3.15 per ton of 2240 lbs.

Plant.—The plant required for work like this is very simple, consisting of a powerful tug, a sufficient number of stone flats, each with a windlass at each end, two heavy row-boats for moving anchors, a supply of four to six heavy anchors, with plenty of rope cable and the necessary small tools.

The Galveston jetties are being completed under a continuing contract, and therefore will not be described.

Pacific-coast Jetties.—The more important of these works resemble each other very closely. They are all riprap jetties on a brush-foundation mattress, and are built from trestles.

San Diego Harbor Jetties.—These are fairly typical. The following description is taken from the specifications for the work:

Trestle.—The present low-water depths on the line of the proposed jetty vary from 1′ to 11′, averaging from 3′ to 5′. The mean range of tide is 4.8′. In building the jetty a double track, standard-gauge, railway will firstbe constructed upon trestlework on the line of the proposed jetty. Brush mattresses will be built on this trestle, covered with a layer of the smaller-sized stone, and deposited on the bottom; and on these mattresses rock will be deposited as required, it being the intention to keep the foundation course as low as practicable at first. The jetty will have its crest at the level of high tide, with a top of 8′ width, and side slopes such as the stone will naturally assume under the action of the waves. The outside slopes and all above a depth of 2′ of water at low tide must be of large rock. The jetty will be raised higher should it be desired. In prosecuting the work, the pilework must not be, in general, more than ten bents ahead of the brush-mattress work. The foundation course, in general, must never be less than 500′ in advance of the completed portion of the jetty.

The railway will be of new steel rails, 40 lbs. to the yard. The trestlework will start from the shore at high-water line, and will be constructed as follows:

Bents will be spaced 16′ apart between centres, each bent will consist of three piles, spaced 11′ apart between centres, each pile at least 12″ in diameter beneath the bark, and driven or pumped into the bottom to a depth of at least 12′, and in all cases to a depth equal to or greater than the depth of water in which it is placed, and so that it shall stand firmly and solidly. The bents are to be capped by a 12″ × 16″ cap of pine, 32′ long, bolted to each pile with a 1″ drift-bolt, 24″ long. Upon each cap will be bolted four 12″ × 16″ pine stringers, in pieces 32′ long, laid to break joints, each stringer to be bolted to the caps at the crossings with 1″ drift-bolts, 24″ long. The stringers will be held apart by chocks of 4″ × 16″ lumber in the middle of each bent, securely spiked to the stringers. Near the chocks in the middle of the bents each pair of stringers will be firmly tied by rods of 1″ round iron, headed and threaded, and provided with two nuts and washers each. A stringer of 3″ × 12″ pine in 32′ pieces, will be driftbolted to the caps near their ends, on each side of the trestle. Where a crossover is built, two-pile bents (piles 8′ apart) properly capped are placed between the regular bents, 12″ × 12″ stringers are placed on the caps, and decked with 4″ × 12″ planking, 8′ long. The rails and guard-rails are spiked to this deck.

Stone.—The rock must be of suitable quality, not liable to disintegrate, of random sizes, never less than 6″ on the shortest diameter, nor less than 50 lbs. in weight. The least dimension must be not less than $\frac{1}{3}$ the greatest. All rock less than one gross ton in weight will be known as small rock, and may be used in sinking mattresses and in the interior of the jetty. Rock weighing a ton or more will be known as large rock, and will be required for the sides and top of the jetty. At least half the rock must be large rock. Rock must be dumped into the work exactly as directed. Stone is paid for per ton of 2240 lbs., in place in the work.

Mattresses.—These will be of variable width, depending on the depth of water where placed, and will probably average 40′ to 45′, varying from 40′ to 75′. When of a greater width than can be made conveniently on the trestle, the mats may be in two parts, one on the trestle, and one outside mat, dumped or floated to place, and sunk by stone from the trestle or from barges. The brush may be any live, reasonably straight wood of durable growth, not over 2″ in diameter at the butt, and must be packed in bundles from 6″ to 15″ in diameter and 8′ to 20′ in length, choked and tied every 4′. Mattresses will consist of two layers of brush placed at right angles to

each other, inclosed between two grillages of poles. The lower grillage is made of poles in two courses at right angles to each other, those of the lower course spaced 3′ apart and to lie in the direction of the jetty axis, those of the upper course spaced 5′ apart—the two courses fastened together securely at the crossings. The grillage will be suspended from the trestle, and upon it will be placed brush bundles, side by side, with brush and butt ends alternating. As soon as one row of bundles has been placed, each bundle will be cut open and the brush spread out fairly even. The next row will be placed lapping the first 4′, butts over tips, and the reverse. This row is then cut open and spread, and so on until the grillage is covered. This course of brush must average 8″ in thickness and must be at right angles to the jetty axis. A second course of brush is similarly laid, at right angles to the first. A top grillage of poles is then built on the brush, similar to the lower grillage, but with the courses reversed. The mattress is then compressed fully one third, preferably by means of screws, and the grillages secured together through the mattress at the panel corners. The mattresses are to be made as wide and thick as desired, and in lengths of four bents. All mattresses must be laid in contact with each other, and when weighted and dropped to the bottom must be loaded immediately with sufficient stone to hold them. Mattresses are measured by calculating the volume of the brush filling, after compression.

The prices bid for this work in July, 1893, ranged as follows: Trestle, $5.17 to $11.50 per lineal foot; mattress in place, $1.97 to $4.75 per cubic yard; stone in place, $1.625 to $3 per ton.

Columbia River Jetty.—This is one of the longest works of its kind in the world. It was constructed by hired labor, and no pains were spared to push the work forward as rapidly and economically as possible. It is located on the south side of the mouth of the Columbia River, Oregon, and extends from the shore on the South Cape in a westerly direction, with a slight curve to the south, for a length of 4½ miles, to a point about 3 miles south of Cape Disappointment, north of the river mouth. The jetty is constructed of rock resting on a mattress foundation, 40′ wide and from 2½′ to 5′ thick, laid upon the sand. When entirely finished the level of the top of the jetty at the shore end will be about 12′ above mean low water, thence for about 2 miles it slopes to a height of 10′, and thence to the end of the jetty to a height of 4′. The mean range of tide is 7′. The jetty is built in water varying from 0′ to 21′ deep, averaging about 15′ deep.

The material was placed in position from a double track, narrow-gauge tramway, about 24′ above the level of low water, supported on piles. The materials of construction were landed at a wharf from barges, and transported on tram-cars to the point where needed, the trestle construction having been kept slightly in advance of the jetty work.

Plant.—The following plant was used on the work, viz.:

6 280-ton and four 450-ton model barges, for carrying stone from the quarries to the jetty.

5 13-ton locomotives, for use on the tramway.

1 portable pile-driver, for working at points inaccessible for the tramway driver.

2 Mundy portable hoisting-engines, 10″ × 16″ cylinders; one Mundy portable engine, 18″ × 13″ cylinders; and one Lidgerwood portable engine, 7″ × 10″ cylinders. These were used with the derricks for transferring materials from the barges to the cars. Power was furnished for the workshops by a single-cylinder engine.

3 derricks, for transferring materials. 1 extra derrick was kept for emergencies.

1 steam-launch, for tender for the work.

1 steam-tug, for towing barges to and from the quarries.

4 mattress-cars, dumping on one side; 2 push-cars; 3 four-wheel and 6 eight-wheel flat cars.

62 dump-cars, for stone, to be described later.

1 tramway pile-driver, for trestle construction, described below.

Mattress-car.—This is a four-wheel platform-car 21′ long. The mattress rests on four rollers, 6′ long, two on each side of the car, near

each end and parallel to the sides. These rollers revolve on trunnions, the beds of which are fixed at the corners of two rectangular frames carried at the ends of the car. Each frame rests on four posts 1′ high, and is secured to the posts by round iron bolts so as to form a hinge on each side, parallel to the side. The posts on the side of the car over the middle of the jetty are fixed. Those along the outside of the jetty pass vertically through rectangular holes in the car platform, and are supported so that their tops shall be at the level of the tops of the inside posts, by a shoulder resting on a movable iron bar the length of the car. When the bar is moved longitudinally by a lever, the shoulders come over notches in the bar, and the posts slide down until the frames strike the platform. The frames are thus tilted enough to permit the mattress to slide off.

Stone Dump-car.—A longitudinal beam or "draw-timber" extends the full length of the car. Upon this beam at each end is a rectangular framing, carrying trunnion-beds. Upon trunnions turning in these beds is suspended a swinging or dumping frame, on which is placed the load. At one end, above the trunnion, this swinging-frame has rigidly attached to it a strong framing, on top of which is a toothed-wheel segment, by means of which the frame can be swung on its trunnions. The swinging mechanism works in a strong upright box of plate and angle iron, resting on the trunnion-bed frame. Across the top of this box is a shaft, parallel to the trunnion axis. On one end of this shaft is a pinion, gearing in the toothed segment. Between the bearings in the box the shaft carries the wheel of a worm-gearing. Below the worm-wheel, at right angles to the upper shaft, is a second shaft, one end of which is supported on trunnions on one side of the box. From this the shaft extends through the box, between guides in the other side, and has a hand wheel fixed to its outer end. Under the worm-wheel the second shaft carries a worm. The hand-wheel end may hang loose, or may be lifted so as to throw the worm and wheel in gear, and may be locked in this position by a horizontal releasing-pin. A movable box is placed on the dumping-frame to hold the rock.

When a car is to be dumped a few turns are given to the hand-wheel to bring the centre of gravity of the load to the right or left of the trunnions, as may be desired; the releasing-pin is withdrawn, the worm drops out of gear, and the dumping-frame tips by the run until it strikes the track-rail. The load being discharged, the dumping-frame swings back to the horizontal, the worm is raised into gear and pinned in position, and the car is ready for another load.

The capacity of each car is 10 tons. Two men can unload a train of 20 cars in five minutes. (See Rep. C. of E. 1889, Part IV, p. 2539, and plate, p. 2535.)

Tramway Pile-driver.—The entire mechanism is mounted on a car-frame 17′ long and 19′ wide, of trussed wooden beams, extending over both tracks, supported at each corner by a double truck of 8 wheels (32 wheels in all). Upon this platform is a roller-path 16′ in diameter, of 30-lb. rail. A similar but inverted path is attached to the upper or revolving portion of the driver, running upon 48 steel rollers. The upper platform, 66′ long, is braced by hog-stays, and carries the gins at one end and the boiler, tank, fuel, etc., at the other, so disposed as to balance each other. A steam-pump is carried on a frame suspended outside the track from the lower platform. A flexible suction-pipe drops from this platform to the water.

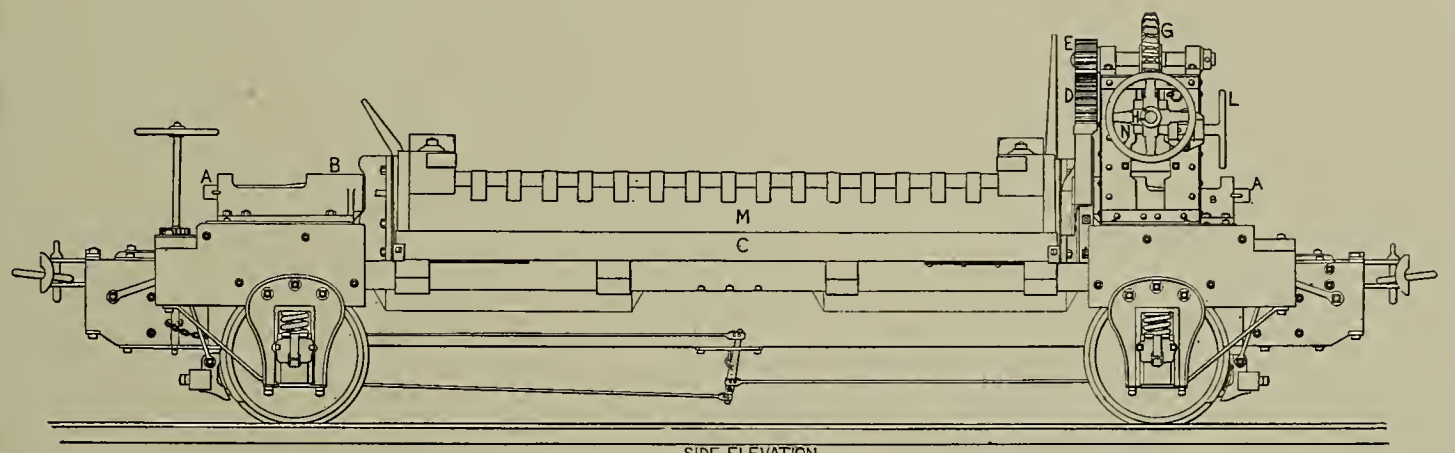
The leaders of the gins are 50′ high. The driver hammer weighs 5000 lbs. The discharge-hose from the pump ($4\frac{1}{2}''$) is connected with a Y, having $2\frac{1}{2}''$ branches, each with a valve-gate. Each branch is connected by a length of hose to a $1\frac{1}{2}''$ jet-pipe long enough to reach to the bottom of a pile when in place.

The process of driving is as follows: A pile is picked up and placed in position between the leaders. The jet-pipes are fastened on either side in such a manner as to follow the pile down, but to be then easily released. The hose connections are then made, the pile is lowered, and the hammer lowered and rested on the pile head. The pump is started and the pile sinks to within 5″ or 6″ of the proper penetration, when the pump is stopped. The jet-pipes are

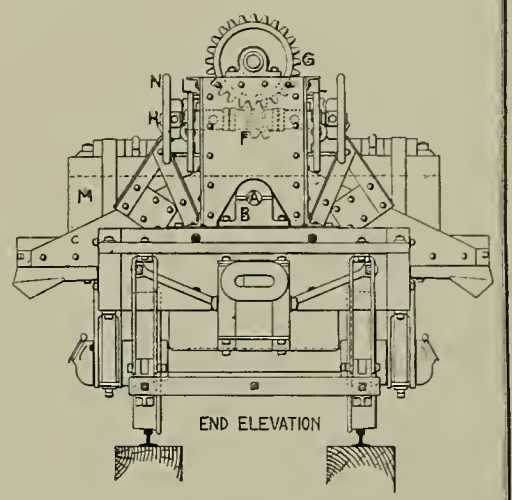
Self-righting Geared Dump Car

Used in Construction of Jetty at Mouth of Columbia River, Oregon.

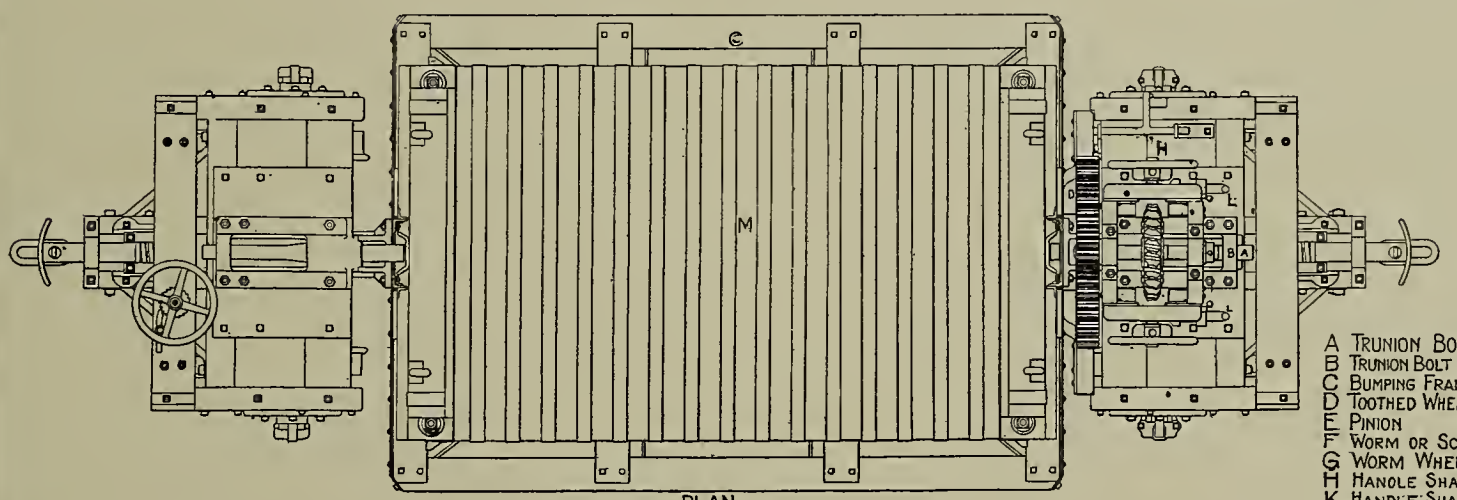
Scale of Feet. 0 1 2 3 4



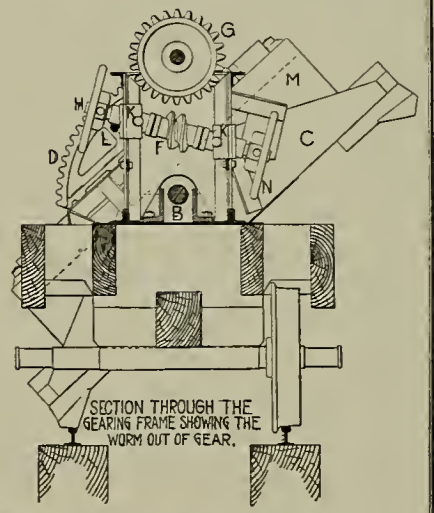
SIDE ELEVATION.



END ELEVATION



PLAN



SECTION THROUGH THE GEARING FRAME SHOWING THE WORM OUT OF GEAR.

A Trunion Bolt
B Trunion Bolt Socket
C Bumping Frame
D Toothed Wheel Segment
E Pinion
F Worm or Screw
G Worm Wheel
H Handle Shaft
K Handle Shaft Bearings
L Releasing Pins
M Movable Box
N Hand Wheel

NOTE. The Center of Gravity of the Box when loaded, is above the Trunion Bolts, when the Box is, empty, it is three and a half inches below.

MODEL OF JETTY AT MOUTH OF COLUMBIA RIVER, OREGON AND WASHINGTON.
Tramway, Pile driver, and Mattress under construction.

MODEL OF JETTY AT MOUTH OF COLUMBIA RIVER, OREGON AND WASHINGTON.
Pile-driver Tender Car, Stone Dump Car, Mattress Car. Mattresses on bottom and under construction.

then pulled away and the pile settled to place by a few light blows with the hammer.

The overhang beyond the forward edge of the forward trucks is 21′. Piles were sunk 22′ into the sand in an average of 4 minutes after the pump was started. The usual day's work was 64′ of tramway. A tender-car carrying a day's supply of materials usually accompanied the driver. (For a more complete description of this pile-driver, with plates, see Rep. C. of E. 1890, p. 3021.)

Cost.—The cost of this work was as follows: Piles, 9 cts. per foot at Astoria; lumber, $10 per M, at Fort Stevens; brush fascines, $2.75 per cord; stone (later contracts), 63½ to 75 cts. per ton in barges, at the quarry or at Portland.

The total cost of the work is about $83.00 per running foot of jetty.

Pile-and-brush Dike, Gray's Harbor, Wash.—This dike is built in the bay and partially closes the south channel, leaving a passageway 1000′ wide and about 8′ deep, and wholly closes the middle channel, with the object of increasing the flow through the north channel. There is little or no trouble to be anticipated from the teredo in this locality. The range of tide is about 8½′.

The dike consists of two rows of cedar or spruce piles, not less than 12″ in diameter at the butt, 6′ apart, and driven not less than 12′ into the bottom, with an interval of 6′ between the piles of each row. On the outside of each row is a waling-strip of two courses of 3″ × 8″ plank, bolted to the piles. The top of the waling-strip is 5′ 5″ above the mean of the low waters. An inside waling-strip of 3″ × 6″ plank is placed on each row opposite the outside strip. The inside of each row is lined with 2″ plank, spaced 2″ apart, placed vertically and extending from the top of the waling-strip down for about 7′. These planks are further held together and to the piles by a longitudinal course of 3″ × 6″ plank at the middle and by one of 3″ × 8″ plank about 3½′ lower. The rows are tied together and braced by 4″ × 4″ braces, spiked to the wales and piles at intervals of 6′ and at right angles to the line of the dike. Wherever it is deemed necessary, the dike is further strengthened by strut-piles and perpendicular foot-piles, placed on each side of the dike.

The base of the dike is protected against scour by a brush mattress, 30′ wide, constructed on floats along and about the piles. It is made of three or more layers of brush fascines of suitable wood, 12′ to 20′ long, and well choked to a diameter of 9″ at intervals of 6′. The fascines of the lower layer were laid at right angles to the line of the dike; those of the second layer parallel to the dike, and so on until the required thickness was attained. The layers were well bound together with wire. The mattress was sunk with stone placed on the porlions extending outside the dike and wired to the mattress. The space between the piles was partially filled with brush fascines laid parallel to the dike. On these, sand-bags and stone were placed. A mattress sill was placed across the gap in the dike.

In the finished dike the filling is 4′ above the mean of the low waters. The stone is in pieces of from 50 to 150 lbs. weight. The sand-bags are 22″ × 36″ grain-bags, each containing not less than 200 lbs. of sand and gravel.

The prices bid for this work in proposals opened Dec. 24, 1892, are: Piles, per lin. ft., 8 cts.; lumber, per M, $10.00; bolts, each, 18 cts.; spikes, per lb., 3 cts.; wire, per lb., 2$\frac{9}{10}$ cts.; brush, per cord of fascines, $2.45; rock, ton of 2000 lbs., 59 cts.; sand-bags, each, 8 cts.

LAKE-HARBOR BREAKWATERS AND PIERS.

Timber-crib Breakwaters.—The general type consists of (1) a foundation of piles and riprap or of riprap alone on the natural bottom, or where the bottom is soft, on gravel or small riprap, in a trench excavated through the soft material to hard-pan or rock; (2) of a course of timber cribs filled with stone, reaching from the foundation to the low Lake level; and (3) of a continuous superstructure, (*a*) of timber in crib form, filled with stone and sheathed on top with plank, or (*b*) of masonry or concrete, or (*c*) of hand-laid riprap with dry-paved crest and slopes.

Foundations.—In the earlier forms of breakwaters the cribs were

sunk directly on the levelled lake bottom. It was soon found that the cribs were liable to settle out of line, either on account of underscour, or by sinking irregularly into soft bottom. To provide against underscour, the side pockets of the cribs were left open at the bottom, so that the stone filling should settle through them, as the sand washed away. This did not in all cases afford sufficient protection, and the present practice is, in addition, to prepare a stable base for the cribs, either of riprap or of piles.

Riprap Foundations.—Where the bottom is soft, a trench is dredged on the line of the proposed breakwater, four to twenty feet wider than the cribs, to hard bottom, or to a depth sufficient to insure stability. This is filled with gravel or small stone to near the level of the original bottom, and covered with larger riprap. The extra width forms a berm of riprap on the two sides of the breakwater. Where the depth of water is great, and the cost of the riprap less than the cost of the timber cribs, this mound of riprap is built higher.

At Erie, Pennsylvania, where the natural depth is 13′ to 22′, the base of the cribwork is placed uniformly at 15¾′ below the water-surface, and rests on a bed of stone 2¼′ to 6¼′ thick, and 28′ wide at the top when levelled, and with natural side slopes. The width of the cribs is 24′. The berm of the foundation is thus 2′ wide on each side, but on the exposed side the base of the crib after placing is protected where required by riprap of heavy stones, weighing not less than 300 lbs. each, piled 8′ high next to the crib and with a base 12′ wide. The cost of such a foundation in 1892 was: dredging, 30 cts. per cubic yard; stone for foundation, in place, $1.90 per cu. yd.; stone for riprap, in place, $2.50 per cu. yd.

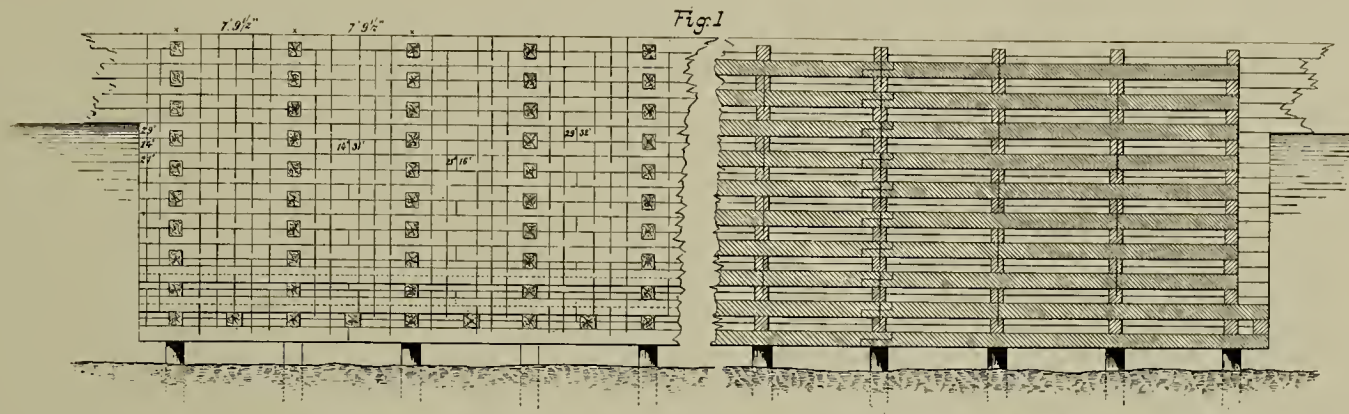
The cribs of the Milwaukee Breakwater are placed in about 35′ of water, and rest on a bed of riprap, having its top levelled off 23′ below the Lake surface. The top of this foundation is 46′ wide, 16′ wider than the cribs, so as to give a berm 8′ wide on each side. The outer slopes of the foundation are 1 on 1, and for a depth of 3′ they are formed of stones which weigh not less than one ton each. In 1892 the cost of stone in the foundation was $7.00 per cord.

The West Pier extension at Agate Bay, Minn., is to be built in water varying from 40′ to 42.7′ deep. On Nov. 10, 1894, proposals for extending the riprap foundation were opened. The top of the embankment is to be brought to a uniform level of 20′ below the plane of low water. It will have a top width of 40′, a bottom width of about 106′, and a slope at end and sides of 1 on 1½, and starts from the end slope of the existing embankment. The average depths for each succeeding fifty feet are 40′, 42′, 42.5′, and 42.7′. The stone is required to be hard and durable in quality, not subject to disintegration from the action of either water, air, or frost. The core of the embankment may be of any sized stones not under 20 lbs. each, but the surfaces of the slopes are to be of pieces weighing not less than two tons. The estimated total amount of rock needed was 3137 cords. The lowest bid received was $50.50 per running foot of embankment. In this work, before the cribs were sunk, the embankment, which had been allowed to settle for at least 30 days, was brought up to the level of 18′ below low water with small stone, and after the cribs were in place their base was further protected with riprap of large stones, as in the Erie Breakwater.

Pile Foundations.—Where the depth is not too great, pile foundations are used to obtain a stable bearing. Generally the piles may be of Norway pine or of any hard wood. They are driven in rows transverse to the breakwater, or longitudinally, and are cut off evenly at the required depth.

The piers of Calumet Harbor, Ill., are built on pile foundations. The South Pier extension was built in water 12′ to 15′ deep. A trench was dredged to a uniform depth of 16′ below low water, and 24′ wide. Four rows of piles were then driven, placed as shown in Plate IX. The piles were of Norway or white pine, from 33′ to 36′ long, not less than 10″ in diameter at the smaller, nor more than 14″ in diameter at the larger end, with the knots and projections dressed off to a uniform taper. The ends were pointed truly in the axis of the pile by four flat faces, not less than 3′ long. The piles were required to be driven accurately in their true positions, and to have a

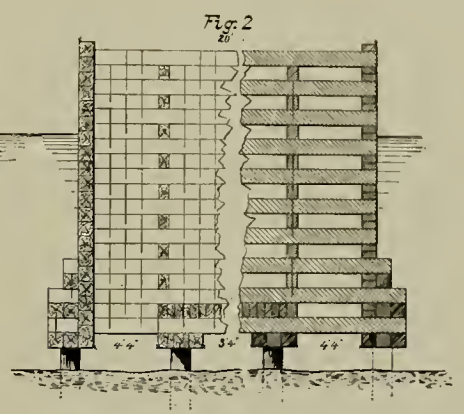
Fig: 1



Half of Front Elevation.

Half Longitudinal Section on line A-B.

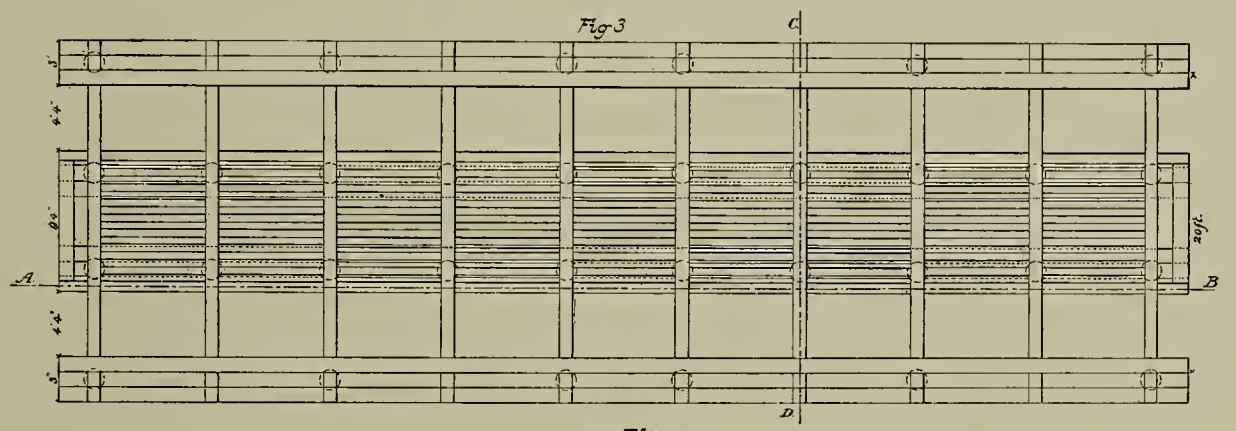
Fig: 2



Half End View

Half Cross Section C-D.

Fig 3

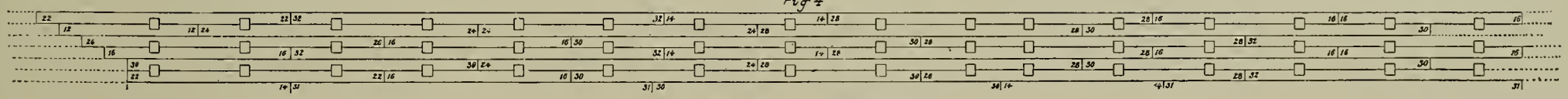


Plan

Cribs 75'x 20'x 20½'

Scale.

Fig 4



Elevation of Superstructure.

PILE FOUNDATION, CRIB, AND SUPERSTRUCTURE OF PIER IN CALUMET HARBOR, ILL.

penetration of between 12′ and 15′. They were sawed off so that the upper end of each was horizontal, and all in the same horizontal plane, 14′ below the plane of mean low water. The cost in 1888 of preparing the foundation, including dredging, was $12 per pile.

In the new pier extension of Racine Harbor, Wis., the cribs are to be 50′ long, 24′ wide, and 17½′ high. They will rest upon a foundation of piles, cut off on a horizontal plane 16½′ below low water. The piles are required to be of white or Norway pine, tamarack, black ash, white oak, or rock elm, each 38′ long, straight and sound, having a uniform taper, with a diameter of not less than 12″ at mid-length of the pile. There will be 28 foundation-piles for each crib, to be driven with precision in four cross rows of seven piles each. The first row is to be driven on precise alignment, 3′ 6″ from the outer extremity of the preceding crib, and at right angles with the direction of the extension. The centres of the piles of each row nearest the sides of the extension are to be driven at a distance of 2′ from the lines of the sides, and the five intermediate piles of each row at equal distances of 3.4′ from centre to centre. The distances between the lines of the centres of the end rows and of the two intermediate rows are to be precisely 14′. The distance between the centre lines of the two intermediate rows will then be 15′.

Cribs.—These vary somewhat in details in different localities. If designed for pile foundations, bearings for the piles are made by widening those timbers of the bottom course which will be directly over the piles by bolting other 12″ × 12″ timbers to them, one on each side, and by building the bearing courses up solid for some distance into the crib. The cribs are built of square 12″ × 12″ timber, hemlock for the bottom courses, and pine for the two or three courses at the top and for the superstructure, all strongly framed and drift-bolted together. The side and end walls are built solid, and smooth on the outside. The crib is strengthened and cut into pockets by transverse walls at intervals of from 8′ to 10½′, and by a middle longitudinal wall, or more generally by two longitudinal walls, placed, in a crib 30′ wide, 7′ from the side walls. The transverse and end walls are framed into the side walls as follows: The lower transverse timber has a full dovetail at each end. This fits into gains cut half into the top surface of the first course and half into the bottom surface of the second course of the side-wall timbers. A solid block abutting against the inside of the side walls is then bolted on top of this transverse timber, thick enough to make the next transverse timber dovetail between the third and fourth courses of the side walls, and so on. The blocking is omitted from the inside longitudinal walls, and in some instances from the inner transverse walls. In most cases only the middle row of pockets is floored, the outer rows of pockets being left open at the bottom so as to permit the stone to fall through them and fill any holes made along the base by scour. If required, the lower courses of the cribs are framed and bolted together on shore.

Sinking.—The cribs are sunk accurately in line, and abutting closely against those previously placed. At times guide-piles are driven, and guide-blocks placed on the cribs, and the cribs are held accurately in place and lowered carefully with the aid of blocks and tackle, and held until a solid base is formed by the stone falling through the side pockets. These precautions are, however, seldom necessary with the level foundations now used. Stone ballast is placed in the central pockets and on deck. The crib is manœuvred into position and held by lines from anchors. Additional ballast is slowly added, and a final adjustment to position is made when the crib is just afloat. When riprap foundations are used, the top is levelled by divers, if necessary, before the crib is sunk. After the cribs are in position on the bottom, the central and side pockets are filled with stone as rapidly as possible, and where necessary the toe is further protected by heavy riprap, as before described. Any intervals unavoidably left between the abutting cribs are carefully bulk-headed and filled with stone. Exposed ends are strengthened with timbers on the inside, or with clumps of fender-piles on the outside. Steel or iron plates are also used on the sides and angles when much pressure from floating ice is to be guarded against.

Wooden Superstructure.—In many localities it has proved cheaper to repair a wooden superstructure as it decays than to make it of durable materials. The substructure, being constantly wet, lasts indefinitely. The tops of the cribs are at the water-level. The superstructure is built on them to the required height, of the same materials and in the same manner, but is made continuous over all of the cribs in place. Intermediate deck timbers are placed between the cross-walls, and the superstructure is finished with a decking of plank, placed longitudinally and spaced 1″ apart, Snubbing-posts are placed where required, and bolted to the inside walls. At times a crib parapet is placed along the exposed front.

Cost of Construction.—Plate X, reproduced from the Annual Report of the Chief of Engineers for 1894, shows the cross-sections of the various forms of cribs used in the works in the harbor of Chicago, with a table showing the relative amounts of materials used, and the relative cost. The cost of other typical work is as follows:

Calumet Harbor, 1888.—Cribwork, 75′ long, 20′ wide, 20½′ high, on pile foundation:

Bill of Materials.

		Crib.	Superstructure.
Bottom, side timbers, hemlock, 12″ × 18″	ft. B.M.	2,700	
Side and bearing timbers, pine, 12″ × 12″	" "	1,800	10,800
" " " hemlock, 12″ × 12″	" "	36,672	
Cross-ties, hemlock, 10″ × 12″	" "	15,987	6,720
Longitudinals, hemlock, 8″ × 12″	" "	7,280	3,600
" " 6″ × 12″	" "	3,672	
Drift-bolts, 1″ sq., 32″ and 20″	No.	588	294
Screw-bolts, 1″ round, 38″	No.	40	
Stone	cords	127	55

Cost in place: 32 pine piles, $12 each; hemlock, $23 per M; pine, $26 per M; drift-bolts, 4 cts. per lb.; screw-bolts, 5 cts. per lb.; stone, $9 per cord.

Total cost per 75′, $4,477.35.

Milwaukee, Wis., 1892.—Five cribs, each 100′ long, 24′ wide, and 22½′ high, on stone foundation with top 20′ below the water-surface, in water of 35′ average depth.

Bill of Materials for Crib.—All timbers are 12″ × 12″ square, except the lower section of the side timbers, which are 6″×12″. All pine.

Pine timber, 12″ × 12″ and 6″ × 12″, 140,340 ft. B.M.; pine plank, for decking, 4″ × 8″ × 16′, 6,912 ft. B.M.; spikes, 10″ × ½″, for decking, 730 lbs.; screw-bolts, 18″ × 1″ rnd., No., 58; drift-bolts, 1⅛″ rnd., 32″ long, No., 1380; 24″ long, No., 156; 20″ long, No., 174; stone, cords, 303.

Prices.—Pine timber, $18 per M; pine plank, $17 per M; drift-bolts, 4 cts. per lb.; screw-bolts, 4 cts. per lb.; spikes, 4 cts. per lb.; framing pine timber, $5.50 per M; laying pine plank, $1 per M; stone, $7 per cord.

Erie, Penna., 1892.—8 cribs, 50′ × 24′ × 16′, on stone foundation in dredged trench. Base of cribs protected by riprap.

Cost.—Dredging, per cu. yd., 30 cts.; stone for foundations, in place, $1.90 per cu. yd.; stone for riprap, in place, $2.50 per cu. yd.; pier extension, per lin. ft., $69.

Concrete Superstructure, Lake Arm, Buffalo Harbor Breakwater.—The old timber-crib superstructure having rotted, it is being replaced by masonry. The cribs are cut down to 2′ below the water-level. On this is placed a platform of concrete 5′ thick, the width of the cribs, and vertical on the harbor side; and on the lake side vertical for 1′, and with a slope of 5 on 3 for the remaining height. Along the lake side of this platform is placed a parapet with its outer toe coincident with the edge of the platform. This parapet is 20′ wide at the base, 17′ wide at the top, and 9′ high, and has side slopes of 6 on 1. (See Fig. 3.)

A row of concrete blocks 4′ high is first placed along the lake face, and one 3′ 6″ high on the harbor face. Concrete in mass is then placed between, and on these blocks to the level of 3′ above water-level. The remainder of the superstructure is then built to full height, with concrete in mass, placed between wooden forms, in the usual manner. The blocks for the lake face are headers 6′ long, 4′ 2″ wide, and 4′ high, with the lake face built to the proper slopes. The harbor-face blocks are rectangular. The moulds for these blocks

FIG. 1

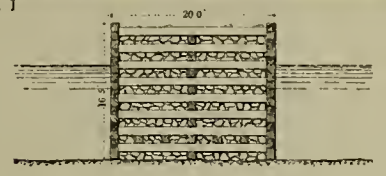


FIG. 2

To accompany the annual report for the fiscal year ending June 30th 1894.

Capt. Corps of Eng'rs U.S.A.

Cross Sections of Crib Constructions used in CHICAGO HARBOR

Scale

FIG. 3

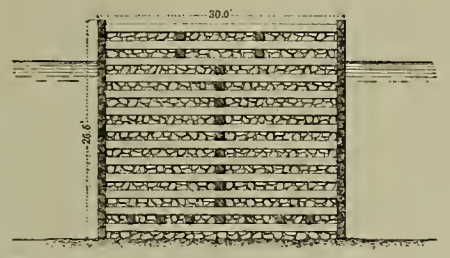


FIG. 4

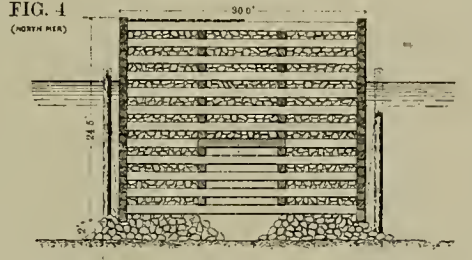


FIG. 5

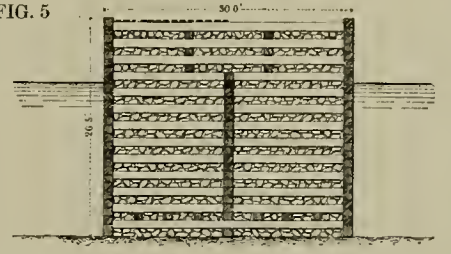


FIG. 6

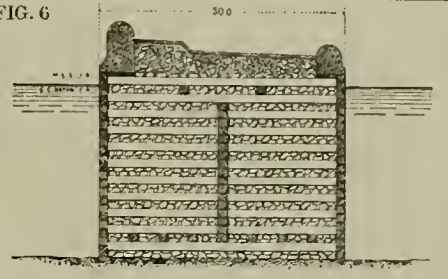


FIG. 7

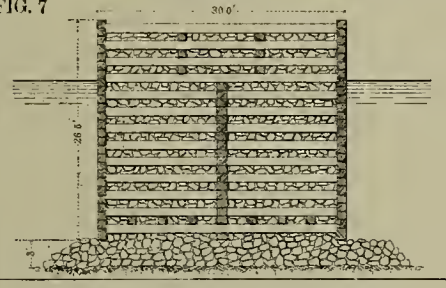


FIG. 8

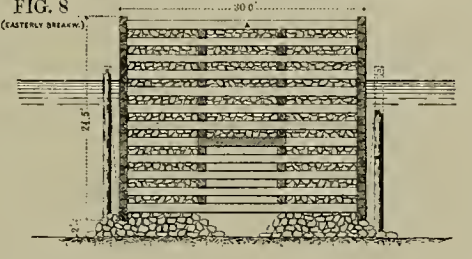


FIG. 9

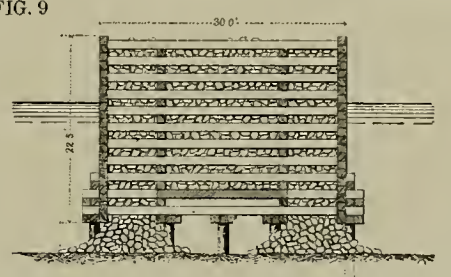


FIG. 10

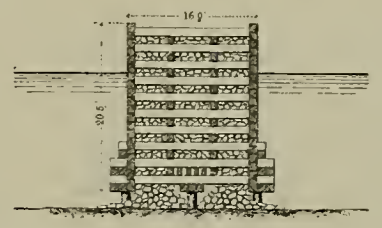


FIG. 11

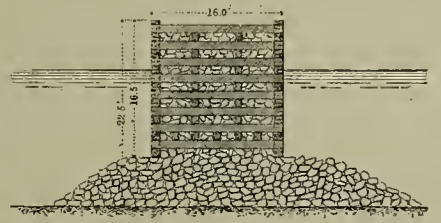


FIG. 12, A.

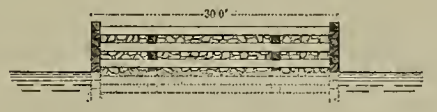


FIG. 12, B.

FIG. 13

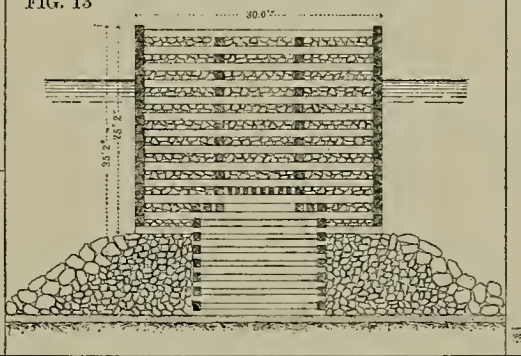
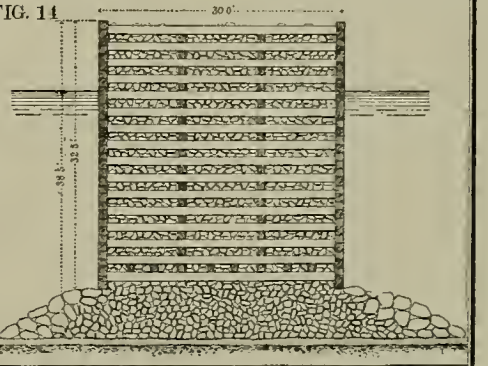


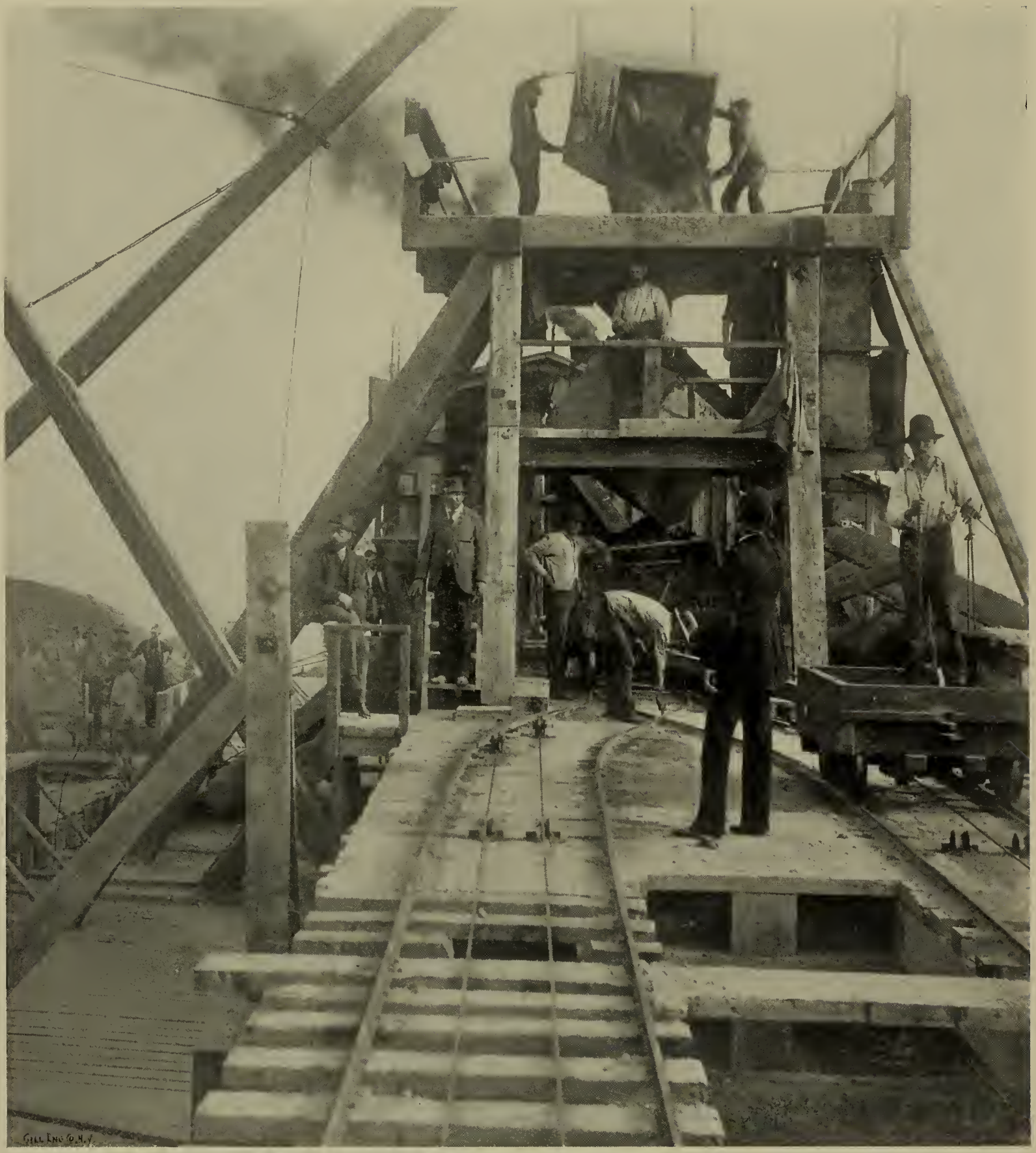
FIG. 14



Relative cost of Pier work, 100 lin. ft. in length, 20½ ft. high, according to different plans used in CHICAGO HARBOR.

	Height	Width	Fig.	How much built L ft.	When	Where	MATERIALS REQUIRED: Timber Ft. B.M.	Dr. Bolts Lbs	Stone Cords	Piles No.	COST: Timber $	Dr. Bolts $	Stone $	Piles $	Totals $	per L ft. $	Add'l each 2 Add'l courses	PERCENTAGES OF COST: Timber %	Dr. Bolts %	Stone %	Piles %	AVERAGES OF ALL THE DIFFERENT PLANS EXCLUDING THOSE WITH PILE FOUNDATIONS: Timber %	Dr. Bolts %	Stone %	REMARKS
Cribs and Superstructure	20½' Incl. Stone on Pile found.	30'	3	400	1864-'69	North Pier	152.736	18.490	338.2	0	4.276.61	739.60	2.029.20	0.00	7.045.41	70.45	681.36	60 7	10 5	28 8	—	56.56	8.77	34.67	Bottom side timbers 12"×18" All others 12"×12"
			5	2250	1870-'72	Easterly Br. Water																			Cribs with grillage, sunk on sand bottom.
			4	600	1875-'76	North Pier	113.520	10.712	307.1	24	3.178.56	428.48	1.842.60	288.00	5.737.64	57.33	643.83	55 4	7 5	32.1	5.0				Cribs suspended by chains 4 above Lake bottom.
			8	150	1875	Easterly Br. Water																			Stone foundation 4' high, 20' wide, fig 4 & 8.
			7	1900	1873-'75	Easterly Br. Water	124.176	14.735	407.0	0	3 476.93	589 40	2.442.00	0.00	6.508.33	65.08	681.36	53.4	9.1	37.5	—				Stone foundation 4' high, 20' wide
			9	300	1879-'80	Southerly Br Water	155.100	11.220	340.0	53	4 342.80	448.80	2.040.00	636 00	7.467.60	74.68	593 35	58 2	6 0	27 3	8.5				Pile foundation. Bottom of Cribs 2' above Lake bottom.
			13	4251	1881-'87	Exterior Br. Water	115.738	9.724	279.7	0	3.240.66	388 96	1.678.20	0.00	5.307.82	53.08	542.40	61.1	7.3	31.6	—				Ties 10"×12". Long'ls 8"×12". Stone bottom 6"×12" etc.
			14	1162	1888-'89	Exterior Br. Water	87.388	7 235	523.5	0	2.446.86	289.40	3.141.00	0.00	5.877.26	58.77	602.75	41.6	4.9	53.5	—				Stone foundation 6' high. Ties & Long'ls 10"×12"
		20'	1	1225	1868-'69	South Pier	115.560	13.904	218 7	0	3 235.68	556.16	1.312.20	0.00	5.104.04	51.04	487.74	63.4	10 9	25.7	—				Cribs 50 long Ties & Long'ls 12"×12"
		16'	10	2700	1879-'80	Southerly Br. Water	89.093	4.667	177.0	27	2.494.74	186 68	1.062.00	324.00	4.067.42	40.67	367.20	61.3	4.6	26.1	8.0				Pile foundation Bottom of Cribs 2' above Lake bottom.
			11	500	1889	Southerly Br. Water	63.880	5.436	314 2	0	1.788 64	217.44	1 885.20	0.00	3.891.28	38.91	383.60	46.0	5.6	48.4	—				Stone foundation 6' high
Superst.	6 ft.	30'	12 a	300	1893	Southerly Br. Water	33.420	3.800	91.3	0	935.76	152.00	547.80	0.00	1.635.56	16 36	561.79	57.2	9.3	33.5					Ties & Long'ls 10"×12" No solid end wall except at end of pier.
		20'	4	1225	1893	South Pier	28 680	3.387	60.8	0	803.04	135.48	364.80	0.00	1 303.32	13 03	445.44	61.6	10.4	28.0					
		16'	12 b	2200	1893	Southerly Br. Water	27.540	3.272	50 4	0	771.12	130 88	302.40	0.00	1.204.40	12.04	410.67	64.0	10.9	25 1					
Concrete Superst.	6'	30	6	95	1887	Easterly Br. Water	Blocks 95 C.Yds	Lining 8.5 C.Yds	Rubble 267 C.Y	Plank F.B.M. 10.050	Blocks $ 950 00	Lining $ 85 00	Rubble $ 1.602.00	Plank $ 284.40	2 918 .40	29 .18									Lake ward blocks 6' high Land ward blocks 4' high.

NOTES: To make comparison possible, between the different plans of construction, materials and cost have been calculated for the uniform height of 20 1/2 ft (20 courses) including stone and pile foundation where used, for cribwork; and 6 ft for superstructure, and at the following prices: Timber $28.00 per M. ft. B.M. Dr. bolts 4¢ per lb, Stone filling. $6.00 per cord. Piles, driven $12.00 each. Concrete blocks and lining: $10.00 per c. yd. Rubble concrete $6.00 per c. yd. and Plank (for support of concrete) $28.00 per M ft. B.M



CONCRETE PLANT, BUFFALO HARBOR BREAKWATER.

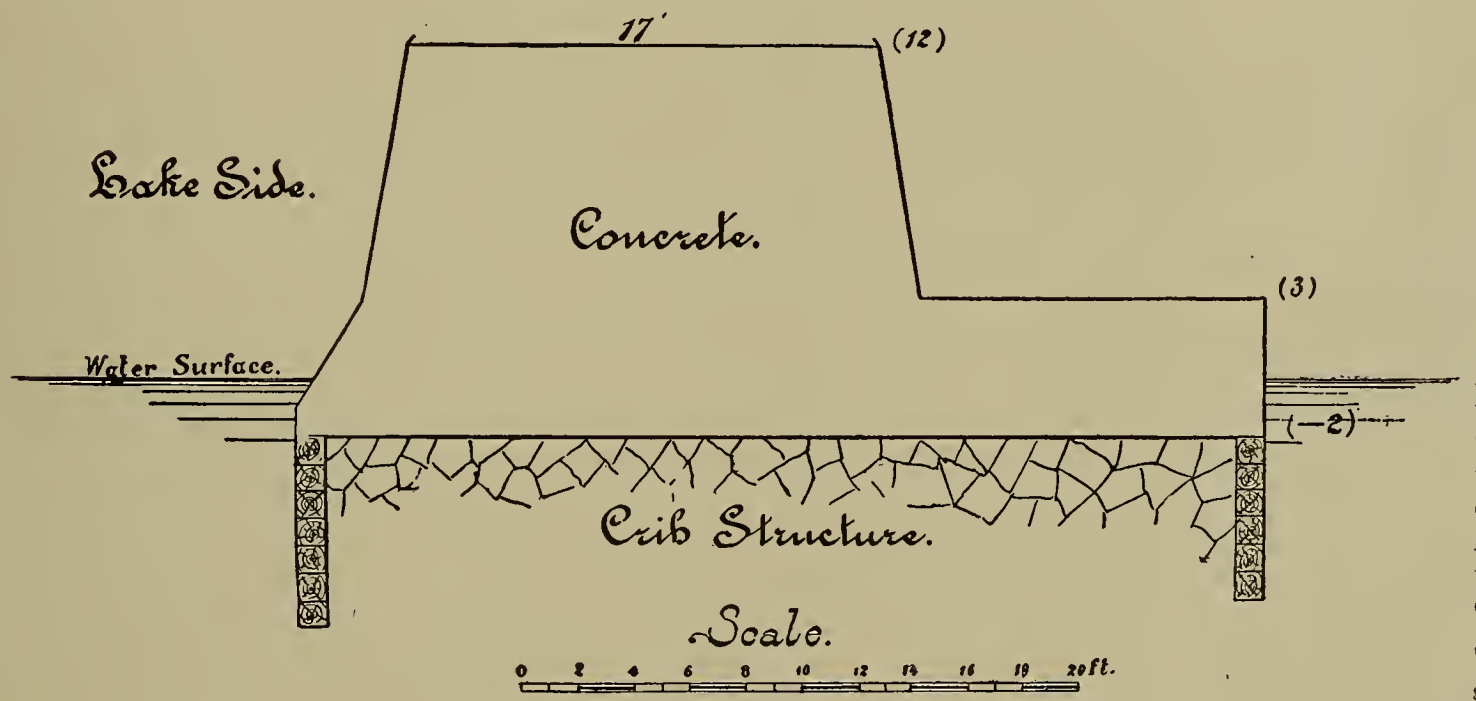
consist of a bed, two solid sides, the end pieces, and the tie-rods. The end pieces are of plank, 6″ wide. They are placed in succession as the block is built up, being held in place by grooves and battens on the sides, so placed as to give the proper slopes. The moulds are tied together by rods with nuts, A groove for the hoisting-chains by which the block is handled is formed in each side and bed by battens with trapezoidal cross-section, fastened to the mould.

The blocks were made on scows near where they were to be used. The proportions for the concrete were: Cement, ½ bbl.; sand, 2½ cu. ft.; pebbles, 7½ cu. ft.; broken stone, 7½ cu. ft. Concrete without the coarse material was used for the face of the blocks. It was placed in the mould to a thickness of about 6″, for 6″ to 8″ around the edge, and rammed. The coarse concrete was then placed inside this ring and rammed, and in this way the block was built up, with a good bond between the two classes of concrete. The blocks were placed by means of a derrick scow with a steam-hoist. To make this scow sufficiently steady under wave-action a second scow was rigidly fastened alongside, by sixteen 12″ × 12″ timbers, in pairs, across the decks and bottoms of the two, each pair being united at the ends and between the scows by iron straps.

FIG. 3.

Cross Section of Concrete Superstructure

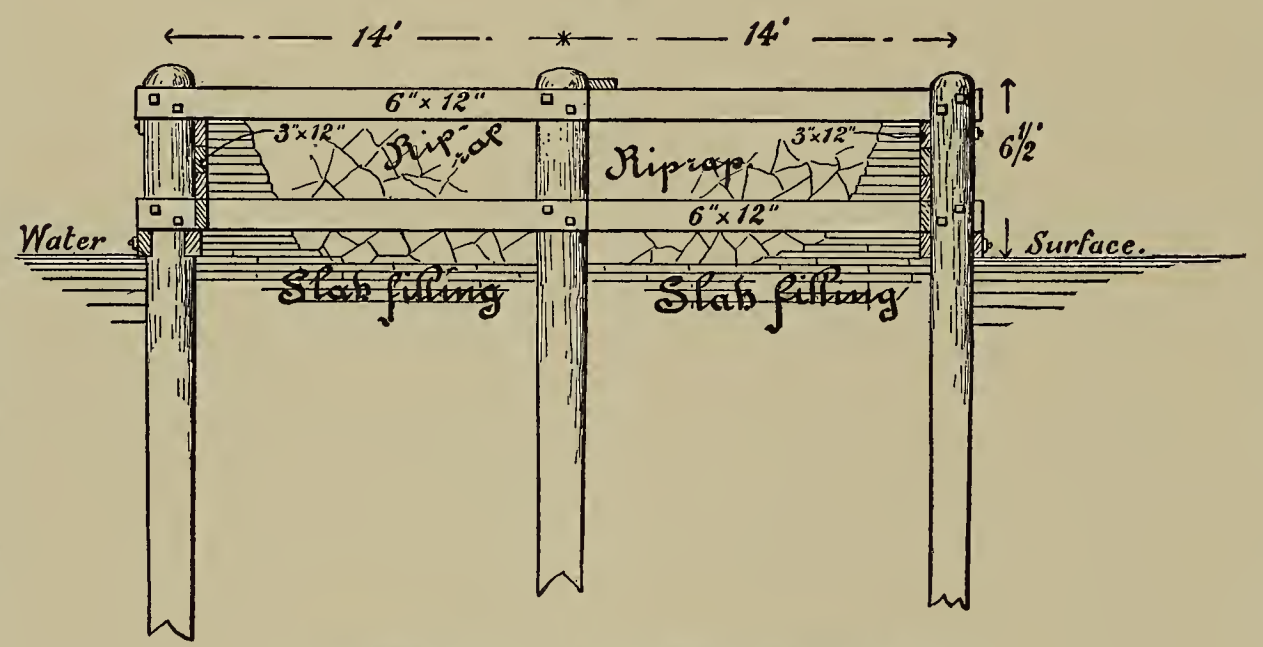
Buffalo Breakwater.



The mass concrete was placed with the following plant: The length to be covered was divided into two parts. Opposite the middle of each part a mixing platform 90′ square was built on piles spaced 10′ in each direction. This was firmly braced against the cribwork, and protected against waves on the lake side by a solid sheathing. A double track was then built on trestles for the entire length, and connected with the platforms. It is 2′ above the level of the finished parapet. The cars are moved by a wire cable, operated by a steam-engine. The cable grip is worked from small platform-cars to which the dump-cars are coupled. The equipment for each platform is: One concrete-mixer, box pattern; one double-drum, double-cylinder, non-reversing hoisting-engine, 7″ × 10″; 3 hand-carts of 15 cu. ft. capacity each—one for pebbles, one for broken stone, and one in reserve; one hand-cart for sand, of 5 cu. ft. capac-

ity ; two charging-boxes of 40 cu. ft. capacity each, for receiving the charges and hoisting them to the mixer ; one derrick ; one steam-pump ; 6 dump-cars. On the side of the platform away from the breakwater are three bins—one for sand, one for pebbles, and one for broken stone. Those for the stone and pebbles have three times the capacity of that for sand. In the deck of the platform is a hatch through which the charging-box can be lowered to a sub-platform, on which it is filled. The formula for the concrete is : Cement, 1 bbl. ; sand, 5 cu. ft. ; pebbles and broken stone, each 15 cu. ft. The cement is first mixed to a paste in the charging-box, the other materials are then added with the proper proportion of water, and roughly mixed by hand ; the box is then raised and the charge is dumped into the mixer, from which it finally falls into a dump-car. The amount laid from one mixer in a day of 10½ hours has been as much as 225 cu. yds. 200 cu. yds. is considered a poor day's work.

FIG. 4.



Cross-section of Pile-and-slab Dike,
ASHLAND HARBOR,
WISCONSIN.

Cost in 1890.—One of the platforms collapsed after it had been in use for a short time. The total cost of the platforms, including the cost of rebuilding the collapsed platform, was $14,390.

The cost of Portland cement per bbl. ranged from $2.25 to $2.45 ; of natural cement from 82 cts. to $1.20 ; of sand, 80 cts. per cu. yd.; of pebbles, $1.75 per cu. yd.; of broken stone, $2 per cu. yd.

The moulds cost $2.86 per block, and the blocks, including material and labor, each $30.32. The total cost of one block in the superstructure was from $35 to $37 ($10.63 to $11.24 per cu. yd.).

The cost of concrete in place, including the cost of the platforms but deducting the value of the other plant, was $7.03 per cu. yd.

Pile-and-slab Dike, Ashland, Wis.—A cheaper form of breakwater was built at this place, which has proved to be an economical type for use in sheltered positions in a lumber country. In its latest form it was constructed as follows (see Fig. 4) :

Three rows of piles were driven, 14′ between centres. The piles of the two outside rows were spaced 4′ apart between centres, and those of the middle row 8′ between centres. The piles were driven vertically 14′ into the bottom. They were sawed off 6½′ above the water-surface, and had their tops slightly rounded. The piles of the outside rows were notched on the outside and inside faces to a thickness of 14″, just above the water surface, to receive on each side a waling-strip of 6″ × 12″ pine. The wales of each row were bolted together through each pile with 1″ screw-bolts, with nuts and washers. The pieces of each wale were joined on the piles, with butt joints, so arranged that the joints of the outside wale should overlap those of the inside wale by the distance of at least two piles.

Wherever these butt joints came, each end was bolted to the pile. In that case the bolts were placed diagonally, and the nuts and washers were countersunk into the wale at the required angle. Cross-ties of 6″ × 12″ pine were placed every 8′, bearing on the piles of the three rows, and bolted to each pile with 1″ screw-bolts. On the inner face of both of the outside rows, the space between the top of the wales and the bottom of the cross-ties was boxed with 3″ plank, fastened to each pile with $\frac{5}{8}$″ × 7″ spikes, and the top course additionally with $\frac{1}{2}$″ screw-bolts, riveted or clinched on the inside. The dike was divided into compartments, 60′ long, by cross rows of round piles, driven close.

The space within the rows of piles was filled with slabs of any width and length over 8′. The bottom courses and sides near the piling were of long and heavy material, placed longitudinally. The slab filling was brought even with the water and then built 4′ higher along the sides. The remaining space was filled with rock, two-thirds in pieces of 1 cu. yd. each, and the remainder 1 cu. ft. The work was finished by a 12″ walk of 3″ plank, resting on and fastened to the cross-ties for the entire length.

The cost of this work under the contract of October 14, 1892, was $24.90 per running foot.

Brush-and-stone Dike.—A dike of brush fascines and stone, similar in construction to those used in the Savannah and other rivers, has been used with success also at Ashland. This type is fully described under the River Regulation Works.

Pile-and-stone Piers.—These vary in width according to the exposure of the site. They are made tight enough to prevent the passage of sand through them. The pile pier at Kewaunee Harbor, Wis., is made as follows: Two rows of round piles are driven on the line of the pier, parallel and 18′ apart between the lines of centres. The piles on the channel side of the pier are closely driven. Those of the opposite row are driven 3′ apart between centres, and are reinforced by a double line of sheet-piling. The round piles must have a penetration of 12′, and the sheet-piles of 6′. For accurate placing, the round piles are required to be squarely butted, and with tips pointed accurately in the axes of the piles, each by four flat faces, each 3′ long. The sheet-piles are chisel-pointed at such an angle as may be required to insure close driving. The driving is done by the water-jet aided by the hammer. The piles are cut off 6′ above the low-water surface. They are brought to position and secured by oak caps, and wales fastened with screw-bolts, the lower lines of waling being close to the water surface. The two lines are prevented from spreading by iron tie-rods, placed 8′ apart, at the water-level. 12″ × 12″ cross-ties are framed into the caps at intervals of 8′. Cross-walls of round piles are placed on lines 25′ apart. After construction, the pier is filled with stone to the level of the lower side of the cross-ties, and the outer or lake side is protected with riprap of large stone to within 4′ or 5′ of the water surface.

Estimate of Materials for 325′ of Pier.

360 round piles, 40′ long.
144 " " 35′ "
650 pine sheet-pile plank, 3″ × 12″ × 28′.
260 pine deck-plank, 3″ × 12″ × 16′.
41 pieces of white-pine timber, 12″ × 12″ × 18′.
28 " " " " 6″ × 12″ × 24′.
84 " white-oak timber, 6″ × 12″ × 24′.
13 " " " 6″ × 12″ × 16′.
13 " " " 10″ × 12″ × 16′.
28 " " " 10″ × 12″ × 24′.
Wrought-iron spikes, 7″ × $\frac{8}{8}$″, 900 lbs.
" " 9″ × $\frac{8}{8}$″, 600 lbs.
Stone, 1200 cords.
110 screw-bolts, 43$\frac{1}{2}$″ × 1$\frac{1}{8}$″.
110 " 39$\frac{1}{2}$″ × 1$\frac{1}{8}$″.
54 " 32″ × 1$\frac{1}{8}$″.
90 " 30″ × 1$\frac{1}{8}$″.
90 " 26″ × 1$\frac{1}{8}$″.
43 tie-rods, 21′ × 1$\frac{1}{2}$″.
4 " 28′ × 1$\frac{1}{2}$″.

The lowest bid, for 325′ of extension to this pier, opened November 1, 1894, was $36.18 per running foot.

Other pile-and-stone piers on the Lakes are essentially the same in construction, differing mainly in width and in the arrangement and position of the sheet-piling.

Lake Champlain Breakwaters as now Constructed.—These are of three classes: (1) rubble mounds with a coping of large stones backed by rubble; (2) cribwork on a rubble foundation; (3) cribwork, with coping of heavy stones, on rubble foundation.

First Class. These are made by dumping rubble in blocks weighing 200 lbs. and under, along the axis of the work until a mound is formed with natural side slopes, and having a top width of about 56″ at the level of 6′ below the surface of the water. After this mound has settled for three or four months it is built up the height of 8, above low water, with a top width of 10′ and a side slope of 1 on 1 on the harbor side and of 1 on 2 on the lake side, with large stones weighing from 1 to 5 tons, backed with the smaller stone. The large stones are set in part from a derrick-boat and in part from a derrick working on the completed portion. The outside slopes and the hearting are carried up together, so that a good backing is obtained for the large stones. In setting a large stone it is held suspended in position until a sufficient number of small stones have been run down behind it through a trough, and settled home by poles, and then the line is slackened. No joints exceeding 3″ in width are allowed between the outer stones, and these stones are so placed as to present a fairly even surface. This form of breakwater is not used in water more than 12′ deep.

Second Class. This is used in water more than 12′ deep. The rubble foundation is placed directly on the bed of the lake, and a crib superstructure is placed on this. This superstructure is built in four different forms, viz.: (*a*) with both sides vertical to full height; (*b*) with harbor side vertical and the lake side sloping 1 on 1 from about 4′ below the water surface; (*c*) with both sides sloping; (*d*) with crib of full cross-section to about 4′ above low water and with a cribwork parapet on the exposed side. The cribs are made with lighter lumber in the inner longitudinal walls, and these walls and the transverse inner walls are built in open courses and not solid.

Third Class. In deep water and exposed situations the crib work is stopped below the level of low water and a superstructure of stone, similar to the superstructure of class 2, is used, but with an inner slope of about 2 on 1, and an outer slope of 1 on 1.

Cost.—The cost of this work is: Pine lumber, $29 to $30 per M; hemlock, $23 to $25 per M; drift-bolts, 4 to 6 cts. per lb., screw-bolts, 8 to 15 cts. per lb.; rubble-stone, 68 to 90 cts. per cu. yd.; large stone, $1.75 to $2.90 per cu. yd. These prices give, for rubble foundations, 3 cts. per cu. ft.; for cribwork, filled, 6 to 8 cts. per cu. ft.; for stone superstructure, 7 to 10 cts. per cu. ft.

Shore Protections and Revetments.—Sand-catches are described on p. 62 *et seq.* A plank-beam revetment was built along the north side of Pine River, Michigan, as follows: Two parallel rows of round piles were driven along the bank, 18″ apart between the lines of centres. The piles in each row were 8′ apart, between centres, and the piles of each row were placed opposite the middle of the intervals between the piles of the other. They were sawed off level at a uniform height of 6′ above the water surface, and scored down on their inner faces to the water-level, to give a plane sliding-surface for the built beam. The penetration of the piles of the front row was required to be at least 10′ below the bottom of the channel, and for the rear row as great as could be obtained. The piles were required to fulfil the usual requirements as to material, shape, etc. Between the rows of plank a built beam was constructed in sections. Plank 8″ wide and 2″ thick was laid in horizontal courses flat and evenly, one upon the other, the plank in each course breaking joints by lapping at least 3′ over the plank in the course next below, and fastened through two courses and into the third with 40d cut nails, at the rate of one nail to two linear feet of plank, until the beam thus constructed rested on the natural bottom and was high enough to reach to the bottom of the cap, to be described later. At the end of each section the face was made vertical and opposite a pile. Another pile was then driven

Fig.1

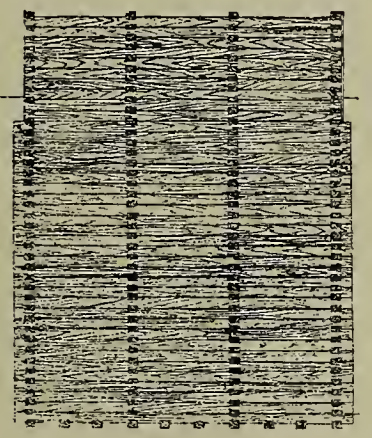
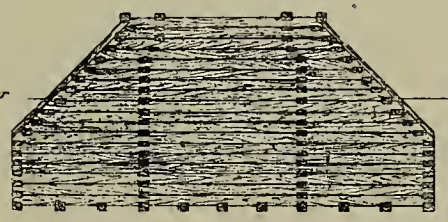


Fig.2



Scale of feet.

10 5 0 5 10 15 20 25 30

Fig.3

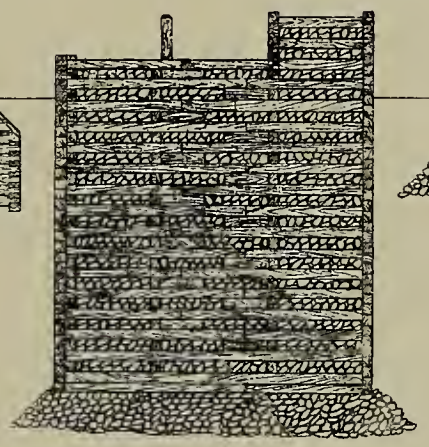
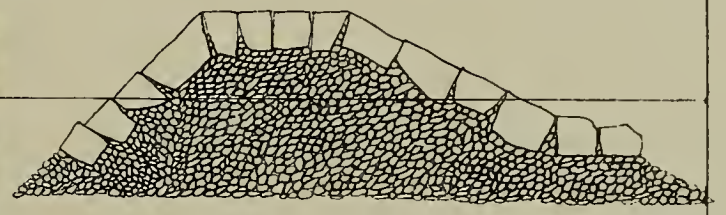


Fig.4

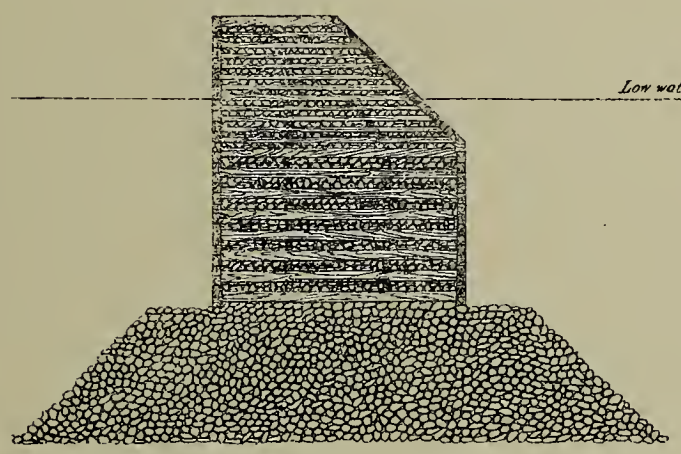


Note

Fig. 1 Part of Burlington and Plattsburg
Fig 2 Swanton
Fig 3 Part of Burlington
Fig 4 Rouses Point and Gordons Landing.
Fig 5 Part of Burlington.
Fig. 6 Approved for Burlington. Recommended for repairs and extension of Plattsburg and construction of Swanton

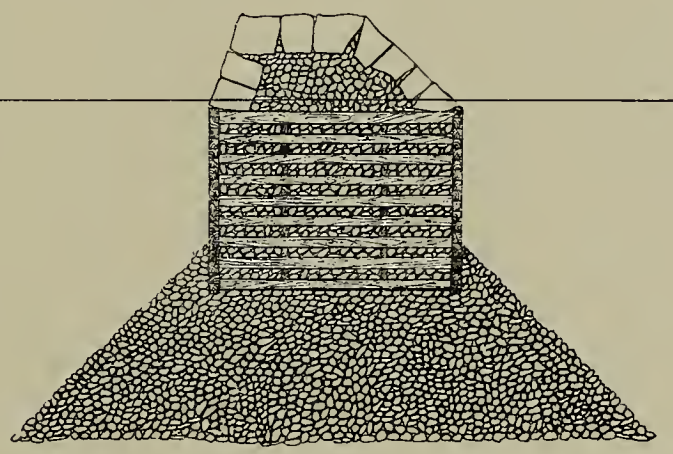
← HARBOR SIDE

Fig.5



EXPOSED FRONT →

Fig.6



CROSS SECTIONS
OF
BREAKWATERS
IN
LAKE CHAMPLAIN, N.Y.&VT.

MODELS OF BRUSH AND ROCK DAMS AND DIKES. IMPROVEMENT OF THE UPPER MISSISSIPPI RIVER.

opposite this joint, in the other row. A cap of timber one foot square in cross-section was then placed on the beam with its top even with the tops of the piles, resting on shoulders formed on the piles by cutting into the piles to a depth sufficient to cause the piles to have a close bearing on the top of the beam and on the cap when sprung in. On the river face of the work the piles were scored down enough to form a rabbet of 1-inch bearing for a $10'' \times 12''$ wale, which was placed along that face, opposite to the cap, secured by a $1\frac{1}{8}''$ screw-bolt at each pile, which passed through the wale, pile, and cap, with the heads countersunk flush with the face of the wale. The pieces forming the wale were jointed on the piles with vertical scarf-joints, 2′ long. The cap-timbers had butt-joints which were placed midway along an interval between a pile in the front and one in the rear row. The cap was secured to the rear row of piles by a screw-bolt at each pile. After the revetment was built it was carefully backed at the foot of all slopes with fascines of brush or with mill-edgings, carefully laid longitudinally behind the work and built up flush with the top and extending back on a level to the natural bank. Above water the plank of the beam had to be of white oak, white or hard pine, or rock elm. Below water any sound wood was allowed. The timber was of white or Norway pine, oak, or rock elm.

The cost of this revetment in 1887 was $4.75 per running foot.

A pile and sheet-pile revetment is described in the description of the abutment at Kampsville Dam, p. 98. In the improvement of Clinton River, Michigan, two kinds of sheet-pile revetment are used. In one, built in shallow water for the protection of the channel through shoal water, there is a single row of piles 8′ centers, with framed cap 5′ above the water, and a $4'' \times 10''$ oak wale at the water surface, backed by a row of $3'' \times 12''$ sheet-piling, spiked fast with 7″ wrought spikes. In the other, situated in water 4′ to 10′ deep, there are two rows of piles with caps, wales, and cross-ties, and a double row of sheet-piling along the channel face. Dredged material is to be placed back of this revetment, to protect it from moving ice. The contract price in 1892 for building 330′ of the single and 890′ of the double revetment was $5734.00.

Bank revetments of piles are frequently made in the same manner as the pile piers before described.

RIVER REGULATION WORKS.

Upper Mississippi River Brush-and-rock Dam or Dike.—This is made of alternate layers of brush-mattresses and stone. The mattresses are made of brush fascines, tightly choked, 20′ long and from 12″ to 15″ in diameter. These fascines are closely packed together and secured by at least three pairs of pole-binders, connected through the mattress by rope or wire ties, not more than 2′ apart.

The mattresses are built directly over the site where they are to be placed, in continuous lengths equal to the length of dam, on scows, provided with inclined ways placed lengthwise of the scow. The mattress scow is placed between a large barge loaded with brush fascines, on the up-stream side and a similar barge loaded with stone, on the down-stream side, all held in position by lines attached to piles or to heavy anchors. The lower binding-poles are first laid on the ways, parallel to the axis of the dike, the fascines laid across them, and the upper binding-poles on the fascines over the lower set. All are then tightly bound together, the end of the mattress is secured, and the scow is pushed ahead from beneath the finished portion far enough to launch the finished work. After a sufficient length of mattress has been made, the floating end is sunk with stone from the stone barge, and the operations of mattress making and sinking are continued until the first course is complete.

This course is covered with 6″ of stone on the up-stream half and with 18″ on the down-stream half. The second course of mattresses is then built over the first course, but 10′ or 15′ farther up-stream. This is then covered with stone. Additional layers are then similarly made and placed, except that each course after the second is laid 2′ farther up-stream than the course next below. When the required height has been attained the top mattress is covered with 1′ of stone near the edges and with 2′ of stone near the middle.

Brush-and-rock Shore Protection, Upper Mississippi River.—This

consists of one layer of brush mattress at the foot of the slope of the bank, extending out into the river and up the slope as far as may be deemed necessary, covered with from 9″ to 2′ of stone. Above the mattress to the level of high water the bank is covered with stone only. Before the mattress is placed the slope is graded and all trees and stumps are removed.

The prices for this work in 1892 varied with the locality, as follows: riprap rock, delivered at work, from 50 cts. to 78 cts. per cu. yd.; riprap rock, laid in place, $1.37 to $1.40 per cu. yd.; brush and poles delivered at work, 28 cts. to 30½ cts. per cu. yd.; brush and poles in work, 47 cts. to 70 cts. per cu. yd.

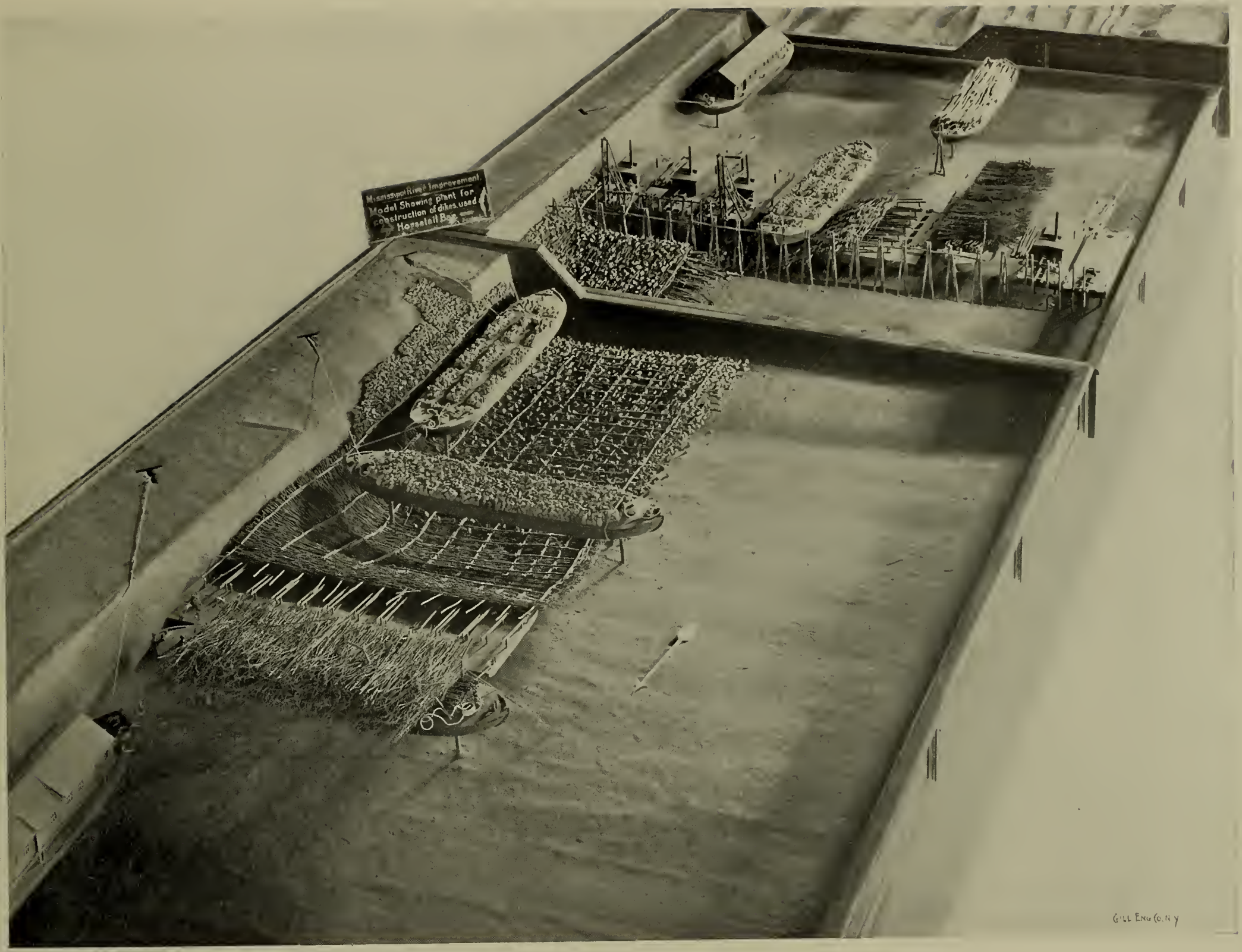
Pile Dam, Upper Mississippi River.—A foundation mattress 20′ wide is first sunk in position. This mattress is similar to those described above. One row of piles, spaced 2½′ apart, is then driven along the axis of the dike, which is 2′ down stream from the up-stream edge of the mattress. A curtain of horizontal brush fascines is then placed against the up-stream side of the row of piles, reaching from the top of the piles to the foundation mattress. Dredged material (gravel and sand) is then banked against the curtain to its full height, and finished with an up-stream slope of 1 on 1½. The lower portion of this slope is revetted with stone and the upper portion with a brush-fascine mattress, fastened down. Stone is banked against the down-stream face of the piles, to the full height and finished with a down-stream slope of 1 on 1.

Permeable Dike or Dam, Upper Mississippi River.—A foundation mattress of the usual type, 12′ wide, is first laid along the axis. Piles, spaced 2½′, are driven on the line of the axis, along the middle of the mattress. A waling-strip spiked to each pile is placed on the up-stream side. A brush-fascine mattress, similar to the foundation mattress, excepting that the pole binders are omitted excepting from the edge next to the piles, is then built along the up-stream side of the piles, of such a width that when sunk, with one edge fastened to the tops of the piles, and bent in against the piles by the force of the current, the up-stream edge shall be about 9′ upstream from the base of the pile row. The fascines are made continuous for the width of the mattress. The mattress is placed by weighting the up-stream edge with stone.

Works on Mississippi River between the Mouths of the Missouri and Ohio.—These works are designed for bank protection, and for bank construction by decreasing the velocity of the current. They are similar to the works on the Lower Mississippi River, but are of a lighter character.

Permeable Dikes, or Hurdles.—The foundation mattress is a basketwork of brush, woven on poles continuously for the whole length of the hurdles, from 1000′ to 3500′. The mattresses are from 65′ to 100′ wide, and are woven on small scows fitted with ways, from which each section, or flat length, is launched as it is completed. The weaving-poles are made continuous by splicing them together, securing the joint with wire and spikes. The loose ends of the brush are fastened to the poles with nails. One cord of brush will make from 125 to 175 sq. ft. of these mattresses. To sink them, 1 cu. yd. of stone is required for every 1½ cords of brush.

Guide-piles are driven slightly in advance of the mattress, in groups of three, 10′ to 12′ apart, to protect the hurdle from drift and to afford an anchorage for the stone and brush barges. The tops of these piles are cut off 2½′ above the level of high water. The groups are connected by a heavy stringer bolted to them about 5′ below the top. About 25′ below this line a second row of piles, spaced 6′ apart, is driven through the mattress, and each alternate pile is strengthened by a brace-pile, driven about 8′ back of it, inclined up-stream, and bolted to it at the level of the stringer of the upper row. A stringer connects the piles of this row also. The two rows of piles are connected by cross-braces, bolted to the two stringers and spaced usually at every joint. All piles are driven large end down by the water-jet and hammer. The lower (braced) row of piles is then wattled with brush. In deep water a brush mattress is made between the rows of piles and beneath the cross-braces. The down-stream edge is attached to the top of the lower row of piles and the up-stream edge



MODELS OF SHORE PROTECTION, PILE DIKE, AND PLANT.

Improvement of the Mississippi River between the mouths of Missouri and Ohio Rivers.

weighted with stone. The mattress then falls as a curtain against the lower row of piles. In order not to bring too great a pressure against the wattled hurdle immediately after construction, before a fill has been secured behind it, the wattling is not usually carried up higher than about 6′ above low water at first.

The shore-protection mattress is made like the foundation mattress just described. Where the currents are strong it is strengthened with wire rope. The bank is prepared, and it is sunk as in the upper river. From 1′ to 2′ of stone are placed on this mattress. The upper part of the bank is revetted with stone.

Cost.—The cost of a completed hurdle has been from $9 to $16 per linear foot. The cost of bank revetment was $6 per linear foot for mattresses 120′ wide, and $4 per linear foot for grading and revetting the bank with stone. The prices for materials in 1892 were: for cottonwood piles, 5½ to 6 cents per linear foot; manilla rope, 11.14 cents per lb.; sisal rope, 7.74 cents per lb.; wire, 2.5 cents per lb.; nails, 2.19 cents per lb.; spikes, 2.73 cents per lb.; screw-bolts, 2.3 cents per lb.

Brush was obtained by hired labor and payment of royalty at a cost of $1.02 per cord. Stone was obtained from a leased quarry, the work being done by hired labor, at a cost of 65 cents per cu. yd. loaded on barges.

Lower Mississippi River Work—Plum Point Improvement.—The Plum Point reach begins about 147 miles below Cairo and extends for 40 miles. The fluctuations of water-level in the reach are as high as 36.5′. The current velocities are at times 6′ to 7′ per second. The improvement of this reach presented all the difficulties of construction found along the river, and the works may therefore be considered fairly typical for design and construction methods. They included bank protection and the construction of dams and dikes. The bank-protection work includes grading, the revetment of the dry bank and the revetment of the slope below the low-water level. The grading and dry-bank work may either precede or follow the river work.

Grading.—This was done by one of two processes, according to the nature of the material in the bank. In one, a cut was made in the bank to the required grade. A movable sluice-box was placed in this cut extending from the top of the bank to the water, through which a stream of water was kept running by means of a pump on a boat, moored below. The material was then cast by shovels into the sluice-box and carried by the water into the river. The box was moved from time to time along the bank.

In the other method hydraulic graders were used. These are barges fitted with powerful pumps and an iron boom-pipe to carry the discharge up the bank. Hose with nozzles varying from 1″ to 2″ lead from the boom-pipe. Streams of water at high velocity are thrown against the bank. A face is formed and carried forward on the required slope, by undermining the material and washing it down the bank. To prevent the water from flowing back over the graded portion, the top of the face is kept slightly in advance. Care is taken to prevent gullying at the foot of the slope. The usual slope formed is about 1 on 4.

Hydraulic Grader —One of the graders used on the work was fitted with two Davidson pumps, having 16″ plungers, driven by two compound condensing-engines of 24″ stroke and 18″ and 34″ cylinder diameters. Steam was supplied by a battery of three boilers, each 22′ long and 44″ in diameter, with five 10″ flues. The suction-pipes were 14″ in diameter. The discharge was through a boom-pipe, 60′ long, having twelve openings fitted with 4″ valves, to which the hose was attached. The maximum discharge from the two pumps was 2000 gallons per minute.

The nozzles were 1¼″, 1¾″, and 2″. When in use the nozzles were bolted fast to a bar held by the nozzlemen. To the bar was attached a long stem, which for the small nozzles was inserted into a pointed pipe well driven into the ground and firmly anchored. The connections were so made that motion in any direction could be given to the nozzle. To hold the large nozzle, a heavy four-legged bench held by two anchors had to be used. The pressures used

were 110 to 115 lbs. at the pumps, and 80 to 90 lbs. at the nozzles. One nozzleman and two helpers were required for the large nozzles, and one nozzleman and one helper for the small nozzles. The crew on the grader comprised two engineers, two firemen, one linesman, and one helper. One grader can remove from 1800 to 4000 cu. yds. of earth per day, at a cost of 2.98 cents per yard, including all operating expenses.

Bank Protection.—This may be either stone revetment for the dry bank and a mattress below, or it may be all mattress work. If of stone only, the dry work is called paving, and extends from the low-water line to about the level of the 18′ stage. It consists of a thin layer of quarry spalls covered by a layer of stone which varies in thickness from 12″ at the base of the slope to 6″ at the top. The mattress protection below the low-water line will now be described.

In this description the bank is supposed to have been graded. The mattress work in the river and on shore are to be carried along together.

Mattress Construction.—An abutment is first prepared at the up-stream end of the portion of the bank to be revetted. It consists of two clumps of two piles each, at the low-water line and 15′ apart, each braced back against a single pile farther up the bank. A line of piles spaced 100′ apart is then driven along the low-water line for the entire length of the mattress. All of these piles must be high enough to allow for the fluctuations of level to be expected during construction, and their object is to keep the inner edge of the mattress always over the low-water line. All of these piles are removed later.

When these are prepared, two mooring-barges are lashed end to end, and are brought alongside the bank above the abutment. Outside the mooring-barges, and parallel to them, is placed a mattress-barge as close to the mooring-barge as the outriggers of the inclined ways will allow. This mattress-barge, for a 200′ mattress, is 212′ long. and has across it ways, inclined at a slope of 1 on 4, and prolonged beyond the side by outriggers. To the outer gunwale of the mattress-barge is fastened a barge loaded with brush, and to each end a barge loaded with poles. After the head of the mattress has been made and secured, the fleet of boats arranged as described is dropped down opposite the abutment, and the up-stream end swung out until the mooring-barges are nearly at right angles to the bank, so that they shall swing to the full perpendicular as soon as the drag of the mattress becomes strong. The fleet is held in this position by six wire cables, attached at equal intervals to the mooring-barges, and anchored to trees or stumps along the bank above. The outside cable is $1\frac{1}{4}''$, the next $1\frac{1}{8}''$, and the remaining three 1″, flexible wire rope. These headlines must be kept carefully adjusted so that the mooring-barge shall remain in exact position, otherwise the inner end of the mattress may swing out of place.

Five wire cables, two of $1\frac{1}{8}''$, two of 1″, and one of $\frac{3}{4}''$ diameter, are temporarily secured to the mooring barges on the up-stream side, at equal intervals, opposite the head of the proposed mattress, the heavier cables on the outside. The ends of these cables are passed under the mooring-barges and are attached to the head of the mattress by straps of 2″ manilla rope, fastened by a pin-shackle. These cables are to form the head-lines of the mattress. They are carried to the bank, up-stream, and secured as soon as the head of the mattress has been launched. They are cast loose from the mattress after it has been sunk in place and are recovered.

To build the head of the mattress, two lines of heavy poles are placed on the ways, over the up-stream gunwale of the mattress-boat. These are strongly spiked and wired together and are made as long as the mattress is to be wide. Weaving-poles 25′ to 30′ long are nailed by their butts at intervals of 8′ to the head poles, and at right angles to them. Each of these weaving-poles lies parallel to and over one of the ways. A top line of head-poles is then spiked on over the butts of the weaving-poles. Light wire rope is fastened to the head-pole, under each third weaving-pole, and is run under the mattress, stapled to the weaving-poles at intervals, to increase the tensile strength of the mattress and to hold the brush in case the poles should break. Brush at least 25′ long, of live straight willow, is now

woven in strips 5′ wide, over and under the weaving-poles, the brush ends being left on top and the tops and butts alternating in direction. When the first set of weaving-poles has been covered, the head of the mattress is pushed to the end of the ways, and secured to the gunwale of the mooring-barges by 18 slip-lines, or slings, which are to be gradually paid out when the mattress is sunk. The weaving is continued and the mattress-barge is dropped back from the mooring-barges as fast as the ways are covered, thus launching the mattress in successive shifts. The mattress-barge is held and manœuvred by lines from the mooring-barges. The top grillage is placed as soon as three shifts of mattress have been launched. This grillage consists of longitudinal poles over the weaving-poles, and transverse poles, 8′ apart for the first 100′ and 16′ apart for the remainder of the mattress. The inner line of poles is of hard wood, and they are spaced 8′ apart for the entire length of the mattress. All of the poles are strongly wired together with No. 10 wire. This grillage strengthens the mattress and forms a crib to hold the stone. The floating portion of the mattress is attached to the mattress-barge by lines which are shifted as the mattress is launched. When about 600′ of the mattress is completed, and floating between the mooring-barges and the mattress-barge, it is ballasted with stone, deposited from barrows on runways, from a stone barge on the outside edge. Sufficient ballast is placed on to sink the mattress until only the poles show above the water. Before the ballast is placed and during construction five wire cables, two of $\frac{5}{8}''$, two of $\frac{1}{2}''$, and one of $\frac{3}{8}''$ diameter, are run over the top of the mattress in continuation of the mattress headlines, and are hauled taut and fastened to the mattress at intervals of 16′. They are run from reels on the mattress-barge, and are made continuous for the length of the mattress.

When the entire length of the mattress has been made it is sunk gradually, from the head down. Stone is thrown on the head and the head-slings are paid out until a stone barge can be floated over the head of the mattress. This is moved gradually shoreward, and a second stone barge is brought over and lashed end to end to the first, extending across the width of the mattress. The two barges are then dropped down-stream, placing stone on the mattress and sinking it as they go. The stone-boats are manœuvred by lines from the mooring-barges and from the shore, and by a towboat at the outside edge. The operation must be managed with extreme care to avoid breaking the mattress.

To weave a mattress 200′ wide, three gangs of 18 men each are required, each under a master laborer and all under a foreman. Each gang works on about one third of the mattress, and is divided as follows: 5 brush-passers; 12 men weaving; 1 man packing the woven brush with a maul.

When used, the shore mattress is woven along with the river mattress. It is made by a gang of 30 to 40 men, under one foreman and one master laborer. The water-space to be spanned by this mattress may vary from 0′ to 60′, according to the stage of water. A small flat is used where the depth of water inside the line of piles along the low-water line requires or admits it. The hardwood transverse binders of the river mattress are prolonged until they reach up the slope of the bank for about 40′, first by a hardwood pole and then by cottonwood poles, all spliced and wired together. These are strengthened by a light wire cable alongside, fastened to the mattress at one end and to the ends of the poles on the slope. These cables also prevent the river mattress from slipping out while being sunk. Upon these transverse poles, and to the top of the slope, are laid, longitudinally, willow or cottonwood poles, 8′ apart, the first set 4′ from the edge of the river mattress. Thus a grillage with 8′ squares is formed. The two sets of poles are wired together at their intersections. The corners are further marked on the bank by stakes, driven into the ground on the lower side of the longitudinal poles. Lashings of wire are fastened to the tops of the stakes and around the poles. Upon this grillage and to the top of the slope is placed a layer of brush, laid diagonally, with the butts all toward the top, breaking joints, excepting along the top of the slope, where the butts are kept in line and form a crest. In the first layer of brush, at the edge of

the river mattress the butts all abut against that mattress. A second layer of brush is then similarly placed, slanting in an opposite direction, with the butts to the top. The brush of the two layers should be at right angles to each other. Longitudinal poles are now placed over the poles of the lower grillage, and on these, transverse poles, 8′ apart, where there are bottom poles (i.e., for 40′ up the slope), and above this, poles 16′ apart. These are all firmly tied together. As fast as the mattress is finished, transverse cables made of 8 strands of No. 10 wire are run across the entire width of the mattress every 16′, and are carried to the top of the bank, hauled taut, and made fast These cables are lashed to the mattress every 16′.

Dikes.—These are made of two or more rows of piles at right angles to the current and bank. The piles in each row and the rows themselves are strongly braced and tied together by a system of horizontal braces of timber at right angles to each other, assisted by horizontal ties of wire cable, running diagonally through the dike, all near the tops of the piles. In cases where great increase of depth with strong currents is expected during floods, this bracing is duplicated at a lower level. An inclined tie of wire cable runs from the base of each pile of the forward rows to the top of the pile of the same bent of the first or second row to the rear. Where necessary to decrease the permeability of the dike, one of the rows of piles has a curtain of brush placed against its face. The base of the dike is protected against scour by a foot mattress, and the bank at the shore end is revetted and protected in the usual manner for a length of 500′, beginning at a point 150′ above the upper line of the dike. To facilitate construction, anchorage-piles are driven above the line of the dike. The great strength given to the dike is necessary to prevent its destruction by drift timber, which gathers in enormous masses, at times to the depth of 12′, against its up-stream face.

Pile Dike Construction Methods.—The positions of all of the lines of piles are carefully marked by ranges. Anchor-piles, spaced 50′ apart, are then driven 150′ above the front line of the dike. In water less than 10′ deep each bent is a single pile. In depths between 10′ and 20′ there are two piles per bent, the up-stream pile being 20′ above the anchorage-line. When the water is more than 20′ deep, each bent contains two piles on the line and one, 25′ up-stream. The piles of each bent are braced together and tied by cables made of eight strands of No. 10 wire. These cables are attached to the up and down stream piles before driving, 20′ from the bottom of the pile. After the piles are in position the cable from each pile is carried to the other, up and down stream, hauled taut and made fast at the intersection of the brace and pile. To the down-stream piles a second cable is attached, also 20′ from the bottom of each pile. These cables are to be used for the foot-mattress headlines, as described below. The penetration of all of the piles into the bottom is 20′.

As soon as a sufficient length of the anchorage has been prepared, the construction of the foot mattress is begun, the bank protection having been completed earlier. This mattress is usually 200′ × 200′ square. It is constructed in a manner similar to the work on the river mattress, previously described, excepting that no hardwood poles are used. The mooring barges are held by manilla lines from the anchor-piles. The wire-rope cables from the anchor-piles are carried under the mooring barges and made fast to the head of the mattress. As many 200′ sections are made as may be necessary for the length of the dike. Each section must overlap the section next inshore by 5′, at least.

The foot mattress having been placed for a convenient length, the dike proper may now be started. The piles are of cypress, long enough to allow for a penetration of 20′ and to have their tops 33′ above the assumed plane of low water. The pile butts are cut to a chisel point, and the piles are driven butts down. The driving is done by the hammer and water-jet combined, the hammer being used first to drive the piles through the foot mattress. One jet-pipe is used with each pile. It is fastened to the pile so that its nozzle shall be a few inches above the base of the pile. It is held fast to the pile by a toggle and six inches of chain, which is lightly spiked to the pile

5′ above the nozzle. The upper end of the jet-pipe is lashed fast to the pile by a few strands of rope. A line is attached to the pipe to draw it free after the pile is in place. Before the pile is driven, the wire cable tie is looped around it 20′ from the base and spiked fast.

The number of rows of piles in the dike varies with the depth of water. When the depth at ordinary high water is less than 20′, three rows of one pile each per bent will suffice. For depths between 20′ and 40′ there are two piles per bent in the front row and one each in the second, third, and fourth. For depths greater than 40′ there are three piles per bent in the front row and one each in the second, third, fourth, and fifth. The piles of each rear row are 2½′ shorter than those of the row immediately in front. The distance between the rows is 25′. The interval between the bents is 7½′. The piles of each row are driven row by row, beginning with the front row. No wire-cable ties are attached to the piles of the down-stream row. A waling-strip or "rider" connects the piles of each row together. It is made of logs 55′ long, spliced together, with a lap of 15′. It is lashed firmly to the piles of each bent by wire cable, drawn taut by a winch and spiked fast. As soon as possible the piles of each bent are braced by logs, 30′ to 35′ long, resting on top of the riders, butts up-stream, and projecting not more than one foot above the up-stream row. The braces are also lashed fast with wire cable. These braces should always lie in the direction of the current, and should be placed as soon as possible, to assist the up-stream piles against the pressure of the drift. When necessary a second system of bracing is placed at the level of 15′ above low water. The final operation is to adjust the foot cables or ties. These are carried down-stream and lashed to the proper piles at the intersection of the pile and rider.

In water less than 20′ deep, with a soft or sandy bottom, 10 to 12 piles per day per driver is considered a fair day's work. Deep water, strong currents, and hard bottom may reduce this number to 3 piles per day. (For further details see Rep. C. of E. 1891, pp. 3601 to 3610.)

During 1893 the cost of work on this reach, not including interest on cost of plant nor office expenses, was: river mattress, $4.276 per square of 100′ × 100′; connecting mattresses, $8.17 per square; pocket mattresses (odd sizes to fill holes), $5.90 per square; grading, 3.8 cents per sq. yd.; paving, 91 cents per sq. yd. Stone cost $1.46 per cu. yd., brush 95 cents per cord, willow poles $1.50 per cord.

The following materials were used:

Per square of river mattress:

Brush, cords,	.948	Wire, lbs.,	8.07	Cable clamps, No.	.114
Poles, cords,	.111	Wire strand, lbs.,	2.9	Staples, lbs.,	.048
Stone, cu. yds.,	.647	Spikes, lbs.,	.4	Piling, No.,	.0092

Per sq. yd. paving:

Stone, cu. yds.,	.385	Spalls, cu. yds.,	.113

Per square of connecting mattress:

Brush, cords,	1.117	Wire, lbs.,	6.716	Cable clamps, No.,	.0078
Poles, cords,	.136	Wire strand, lbs.,	2.024	Staples, lbs.,	.0012
Stone, cu. yds.,	2.228	Spikes, lbs.,	.24		

Spur Dikes, New Orleans Harbor.—Systems of spur dikes are used here and at other points along the river for shore protection instead of the continuous revetment, or in sharp bends, in connection with them. Where there is no existing revetment a foundation mattress is first laid, similar to the river mattress described, except that sawed lumber is used in the place of poles in the lower frame and the thickness is about 2′. Similar mattresses of diminishing width are placed on this. These upper mattresses are made two or three times thicker, and the willow poles are so arranged as to form pockets for the rock. These top mattresses or cribs are so designed that the top of the completed dike has a width of about 16′ and a slope in the direction of the length of the dike of about 1 on 3. The width of the successive cribs is made such that the side slopes of the completed dike shall be 1 on 2. The outer end of the dike is in deep water. The inner end, where it will not interfere with navigation, is carried

up to the low-water line and connected with the high land of the bank, or with the levee, by a spur levee of earth, paved with rock.

Levees—Construction.—The ground to be occupied by the base of the levee is first cleared of all material detrimental to the work, such as vegetable matter, logs, roots, etc. It is then thoroughly broken with a spade or a plough. Where required, a base ditch, 4′ wide on top, 2′ wide on the bottom, and 3′ deep is dug, parallel to the axis of the levee and near its middle line. All logs, roots, etc., found in the digging are to be removed. The ditch is thoroughly cleaned and refilled with clean earth and tamped. The embankment is then built of clean earth, taken from the river side of the levee. When the height of the levee does not exceed 10′, the edge of the borrow-pit must be at least 20′ from the base of the levee. When the height of the levee exceeds 10′, the edge of the borrow-pit must be at a distance at least equal to twice the height of the levee. The side of the borrow-pit next to the levee must not have a slope steeper than 1 on 2.

To allow for shrinkage or settlement, the levees are built to a gross height which exceeds the net height by one eighth of the net height, when the levee is built up with teams and scrapers and all parts are thoroughly compacted; when the levee is otherwise constructed the gross height is to exceed the net height by one fifth the net height. The top width of the levee is generally 8′. The slope on the river side is 1 on 3, and on the land side from 1 on $2\frac{1}{2}$ to 1 on 4, or even 6. The finished embankment is sodded with Bermuda grass, placed in tufts 4″ square, spaced 2′ apart.

All trees are felled for a distance of 20′ on each side of the levee, and entirely removed. Where required, 6″ tile-drains are laid at or near the foot of the land slope of the levee, with branch drains leading away.

The prices on the lower Mississippi for this work in 1892–93 were:

For embankment.....	14	cents to	$30\frac{1}{2}$	cents per cu. yd.
For filled excavation....	10	"	"	$27\frac{1}{2}$	"	"	"	"
For tile-drains.....	20	"	"	50	"	"	linear yard.

Hudson River Dikes.—These are similar in construction to the Canarsie Bay dike already described. They are being constructed under a continuous contract.

Delaware River Dikes.—These are of two types: one is similar to the Canarsie Bay dike, the other is made up of one or more layers of brush mattresses covered with stone. The brush mattresses are similar in construction to those to be described for the upper Cape Fear River, except that poles are used for binders instead of fascines.

The prices paid for pile and stone dikes on the Delaware River in 1891 were as follows:

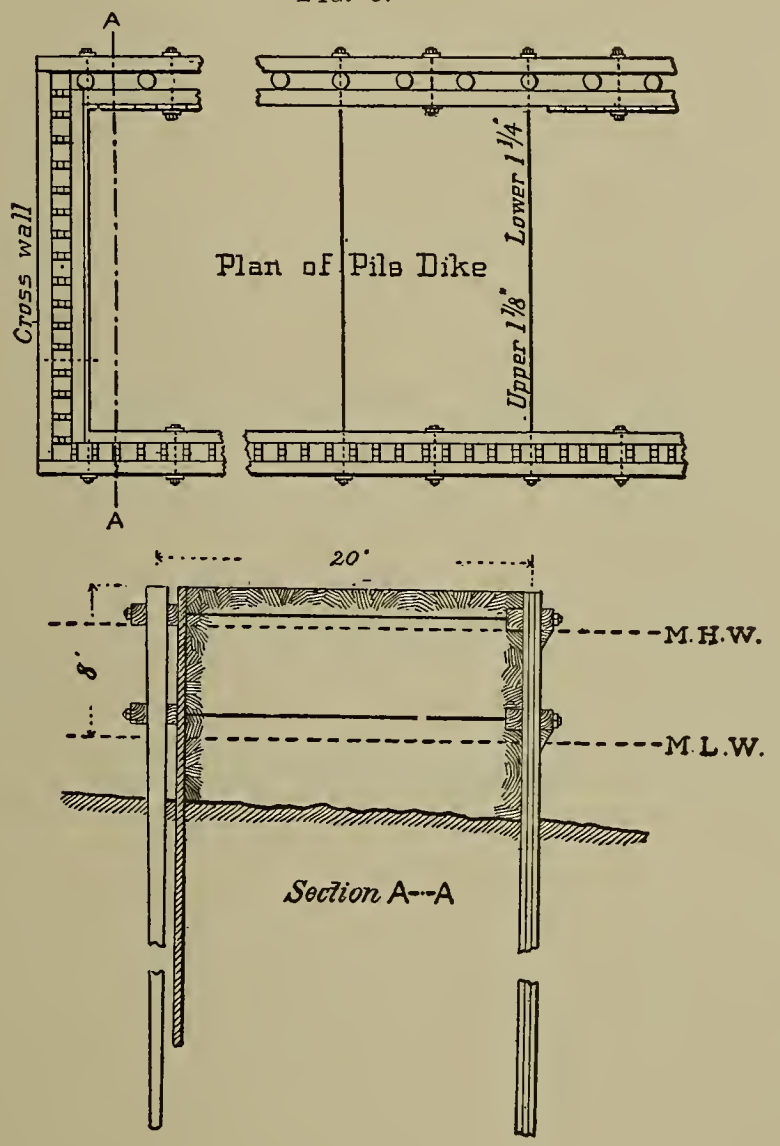
For Delaware pine piles, 14 cts. per lin. ft.; Georgia and Florida pine lumber, $35 per M; white-oak lumber, $36 per M; stone filling, $1.33 per cu. yd.

The prices paid for brush-and-stone dikes in 1888 were as follows: for brush mattresses, $1.55 per cu. yd.; stone, $1.45 per cu. yd.

Schuylkill River Dike. (Fig. 5.)—Pile-and-earth dikes were used in this river, constructed as follows: Two parallel rows of piles were driven 20′ apart. The piles of the outer row are 12″ square, 44′ long when cut off in the work, and tongued and grooved by 3″ × 4″ strips, securely fastened to the piles by 7″ spikes at intervals of $3\frac{1}{2}$′. The butts of the piles were sawed square and chamfered so as to drive closely. The piles of the inner row are round, and not less than 12″ in diameter at the butt. The bark was removed from the portion of the pile above water. The piles were of hemlock, spruce, or pine, and were cut off at a height of 8′ above mean low water. The depth of water was 24′. The dike is exposed in winter to ice. Each row of piles is strengthened by two rows of outer and inner waling-strips, in pieces not less than 20′ long, spliced together against the piles. A continuous angle-block is placed below each wale on the outside of the outer row. The wales and angle-blocks are of Georgia or Florida pine. The two rows of piles are tied together by iron tie-rods, with screws, nuts, and washers, through the upper and lower wales, at intervals of 10′. The upper ties are $1\frac{1}{8}$″ and the lower $1\frac{1}{4}$″ in diameter.

The outer wall of the dike is carried across the outer end of the dike to the rear row of piles. The rear wall is lined for a distance of

FIG. 5.



50′ from the outer end with 3″ plank sheet-piling, 24′ long, spiked to the upper and lower inside wales. The space between the piles is filled with dredged material. The prices paid for this work in 1892 were as follows: for the dike, $15.87 per lin. ft.; for earth filling, 10 cts. per cu. yd.

James River Dikes and Training-walls.—(Fig. 6.) The spur-dikes are built at right angles to the currents, flood and ebb, and when the results attained show that they are of the proper length their ends are joined by training-walls. A row of round piles, not less than 8″ in diameter at the small end, is first driven, spaced 8′ from centre to centre. 6″ × 8″ white-oak wales are bolted to these, one at mean high and one at mean low water mark. A line of 3″ sheet-piling is driven in front of this row. A second row of piles is driven 10′ behind the first, spaced 16′ apart. The two rows are tied together with 6″ × 8″ white-oak struts bolted to the front and rear piles. The struts incline down-stream from the high to the low water mark. A cluster of three white-oak piles, not less than 35′ long, is driven at the outer end of the dike. These are bolted together and the tops bound with chain. The ends of these piles are left as high as possible, as a mark for passing vessels. Their tops are cut off square and capped with sheet zinc. The sheet-piles are spiked to both wales, and the tops of the sheet and supporting piles are capped with 3″ pine plank. Brush, bound in bundles with No. 12 galvanized wire, is placed on the bottom for 10′ up-stream from the sheet-piling, to a thickness of 3′, and is also at times extended for 15′ outside the end of the dike. This is loaded with stone and gravel, to the amount of two tons per running foot, and on this dredged materials are placed to the level of ordinary high tide.

The training-walls are made of two rows of piles, 6′ apart, driven at intervals of 8′ and cut off 2′ above mean high water. A layer of small trees, having length sufficient to project 15′ beyond the face of the dike and 9′ to the rear, is placed on the bottom. across the dike, between the piles, brush ends out, to the thickness of 3′. This is loaded, 2 tons per running foot, with stone and gravel. Brush is then packed between the rows, parallel to the axis of the dike and to the level of the tops of the piles. This is fastened down and to the piles with wire. After it has become

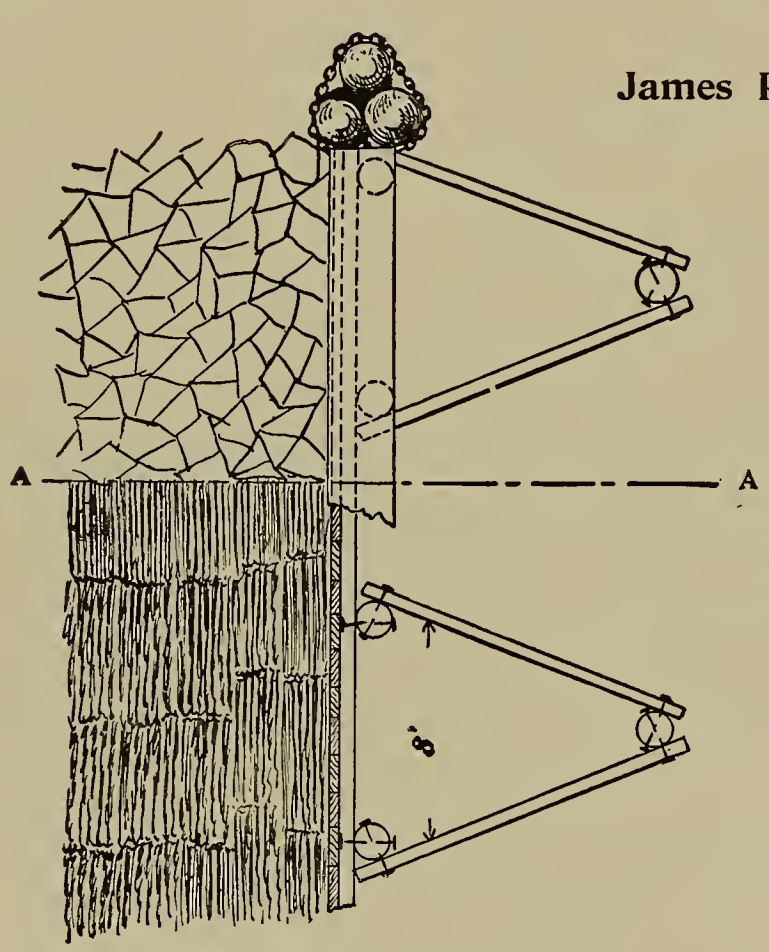
compacted, it is loaded, particularly on the outer face, with stone and gravel.

The prices paid for this work in 1890 were : for pile dike, $2.49 per running foot ; for training-walls, $1.79 per running foot.

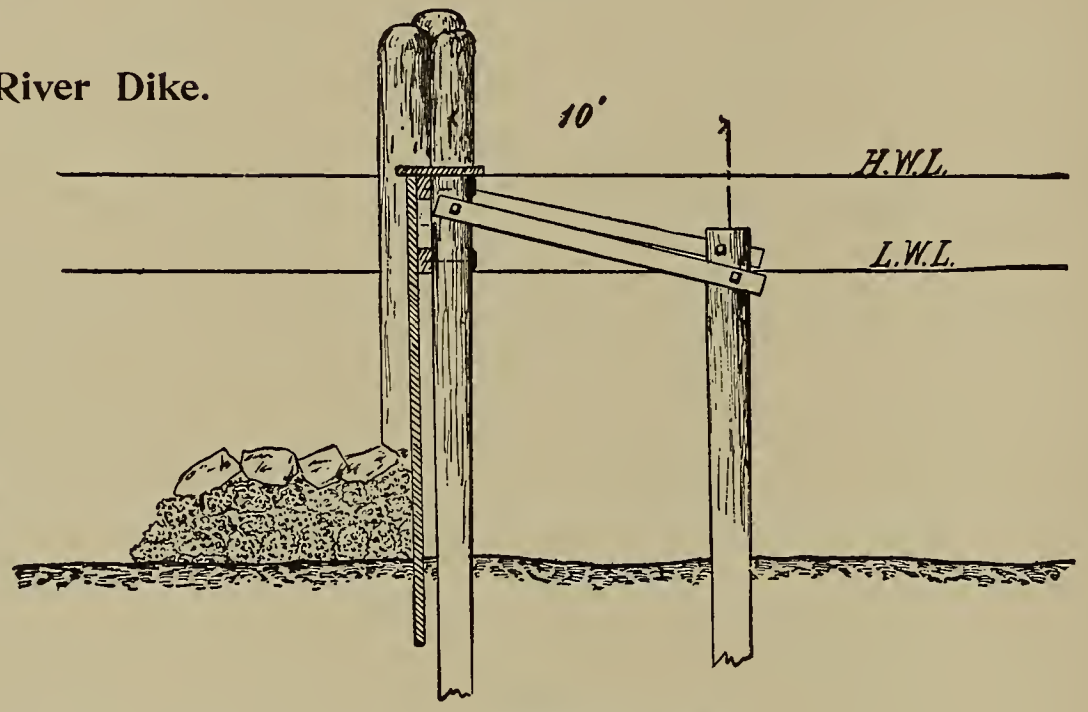
right angles to these, similar fascines 18′ long are laid at intervals of 4′, and the grillage thus formed is bound together at the intersections with wire. On this is laid a layer of loose brush parallel to the axis, a second at right angles, and a third parallel, of such a thickness as to

Fig. 6.

James River Dike.



Plan.



Section on A–A.

Upper Cape Fear River Spur-dikes.— These are brush-mattress dikes covered with stone. To make the mattress, two longitudinal binders of brush fascines, choked to a diameter of 8″, are laid 13′ apart, parallel to the axis of the jetty and equidistant from it. At

give 30″, when loaded with stone. On the loose brush two fascine-binders are placed directly over the bottom binders and the mattress is compressed by ties every 4′, around the two sets. Between these binders two more fascines, choked to 10″ or 12″, are placed, 7′ apart,

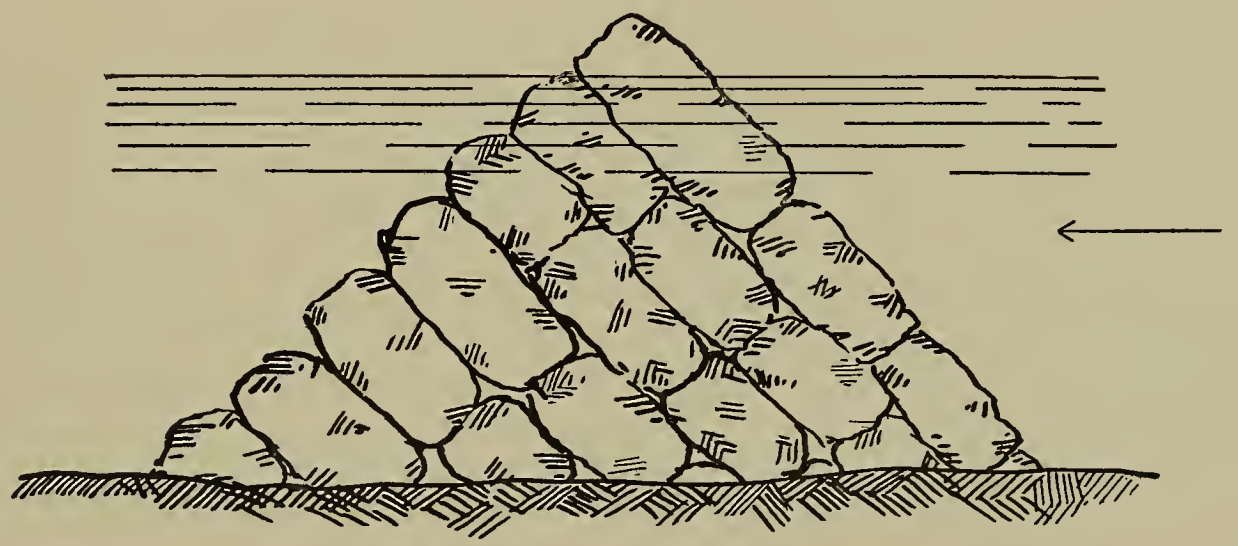
parallel to the axis and equidistant from it. Between these is piled the superstructure of stone, completing the work. These spurs were built in water averaging 2′ deep to the height of 2′ above low water. The spurs cost $2.07 per lineal foot, and contained .35 cord of brush and .86 ton of stone per lineal foot. Stone cost $1.30 per ton of 2240 lbs. on the river-bank at Fayetteville. The cost of loading it on the scows was 16 cts. per ton. All brush was cut from the river-bank in the vicinity of the jetties. The work was done by hired labor with a Government plant.

Savannah River Dikes.—The dikes on the upper Savannah River are similar to the brush-mattress dikes of the upper Mississippi, though a number have been built similar to those on the James River. The prices paid for work there in 1893 were $1.74 per cu. yd. for stone in place in the dike, and $0.74 per cu. yd. for brush mattress in place.

A dike used on the Pacific Coast consists of a row of piles driven at intervals of 6′, well wattled with brush. The wattling was done with brush at least 20′ long, interwoven between the piles and driven to the bottom with mauls. The joints in the wattling overlap, and the pieces are firmly joined with wire. The wattling extends from the bottom to a height of 6′ above low water. To hold the brush down while new, stones were suspended from the top at intervals of 12′, by wire.

The prices for this work were: Piles, 11 cts. per foot; wattling, 5 cts. per sq. ft.

FIG. 7.



Riprap Dikes.—These are made with small stones in the core and larger stones on the slopes and crest. At Eight-mile Bar, on the Ohio River, piles were first driven at intervals of about 40′ to mark the lines of the dikes. The cores were made of stones weighing from 50 to 100 lbs. each. The surfaces for 1′ depth were covered with blocks which weighed from 200 to 400 lbs. each. The tops of the dikes were 5′ wide, and were 4′ above the low-water level. The up-stream slopes were 1 on 1 and the down-stream slopes 1 on 3.

In the Tennessee River, to resist better the impact of floating ice and drift, some of the dikes were in shoal water, of coursed rubble, laid by hand, in courses inclined down-stream from the bottom to the surface. (Fig. 7.)

Crib Dikes.—These are also used. The cribs are made of square timbers, driftbolted together. In some cases the timbers of the cross-walls are dovetailed into the longitudinals, in others they are halved in, and in others simply laid on in alternate courses.

Coffer-dams.—The ordinary types of coffer-dams are too well known to require description. On soft bottom they usually consist of two rows of piles, lined or faced with sheet-piling, spiked to the wales of the piles. The rows are tied and braced across the interior of the dam. The thickness of the dam and the intervals between the piles must depend on the head of water and the strength of the current, as well as on the nature of the material with which the dam is filled.

Pile Coffer-dam, Davis Island.—The coffer-dam used in 1881 in

the construction of the navigable pass of the Davis Island Dam, in the Ohio River near Pittsburg, was of this type. It was 12′ high and 12′ thick and 1457′ long, and contained 7774 cu. yds. of filling. The filling material was a fine sand and loam in such proportions as to make an excellent puddle. The method adopted for placing it in the dam is one which merits a wider use.

The filling material was taken from a borrow-pit on Davis Island, mixed with water, and pumped through 900′ of iron pipe to the end of the dam. Wooden troughs conducted it from the point of discharge to the part of the dam where it was to be placed. The puddle always settled from the water within 15′ of the point where it was released from the trough. It was deposited in a hard, water-tight mass, which under the water-packing completely filled all parts of the dam. Although the dam was so long, and rested upon the gravel and shingle of the river-bed, it proved to be very tight, and the seepage-water was easily taken care of by two centrifugal pumps.

The pump-pit was alongside the borrow-pit and was connected with the river by a sluice. The puddle material was brought to the edge of the pump-pit by scrapers and thrown into it by shovels. It was there thoroughly agitated with the water, the level of the liquid being kept above the mouth of the pump suction-pipe. The process proved a success, even with the crude appliances then available for sand pumping.

Coffer-dam on Rock Bottom.—In the improvement of Rock Island Rapids, on the Mississippi River, it became necessary to devise a cheap form of coffer-dam which could be used in the strong currents found there. The bottom is nearly bare rock, and the depth of water varied from 3′ to 10′. A breakwater was first made 10′ above the site for the dam and a little longer than the up-stream face, by sinking timber cribs filled with stone at intervals of 16′, joining the cribs with strong timbers and closing the openings between the cribs with plank, inclined up-stream at an angle of 45 degrees, with one end resting on the bottom and the other on the connecting timbers and spiked to them.

Under the cover afforded by this breakwater a dam was built, formed of a wall of puddle 8′ to 10′ thick, according to the depth of water, between two lines of sheet-piles, stiffened with two, or in deep water three, wales on each side, outside the sheet-piles, and with heavier upright planks outside the wales at intervals of 10′. Tie-rods connected together the uprights and wales at each intersection, with additional tie-rods through each tier of wales at the middle of each panel. This framing was placed from a small flat, aided by light rafts on each side of the dam. The method of placing was as follows:

A corner frame was sunk, having attached to it at the proper height from the bottom a panel length of one pair of wales for each of the adjacent sides. The outer ends of these wales were kept at the surface by the rafts. To each outer end the upright or "sinking-plank" was attached at a point which would bring the wales horizontal when in place, also the end of the wale of the next panel, the wales and sinking-planks of each section of the dam being held together by the tie-rod. The sinking-planks were then forced down into position and the top wales bolted on by their tie-rods, and so on. The sheet-piles were sharpened to a fine chisel edge, and driven down until they fitted close to all the irregularities in the rock. The filling material was fine gravel and loam.

Kanawha River Coffer-dams.—These are also on a hard bottom, and have proved a cheap and satisfactory type of dam and one which is not subject to severe injury from ice or floods. This type is made of cribs of round logs, sunk in juxtaposition, filled with heavy dredged material of a kind not liable to wash, sheathed with plank, and banked around the outer face of the dam with puddle covered and protected by dredged material and stone. The cribs are placed in a trench, previously dredged on the proper line to the hard-pan or rock. In Dam No. 7 the cribs for the lock coffer-dam were 15′ wide, 21′ long, and 19′ high, the top of the coffer-dam having been about 11′ above the low-water level.

Timber-and-canvas Coffer-dam, Des Moines Rapids Canal, Mississippi River.—This form of coffer-dam was used in the fall of 1893

PLATE XV.

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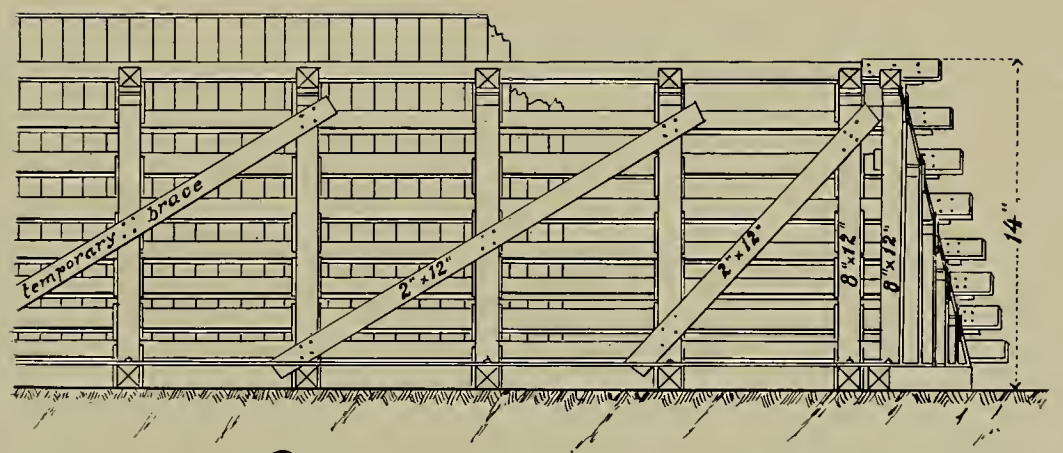
U. S. D. M. R. Canal.

Canvas and Plank Bulkhead,

at Lower Lock.

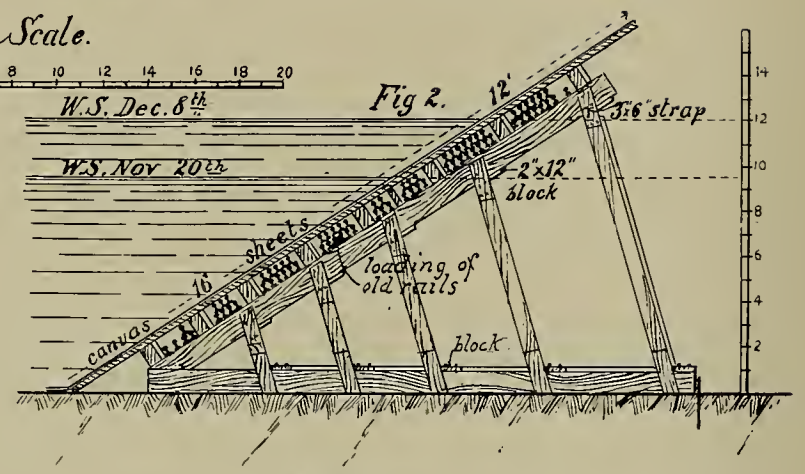
Keokuk. November 1893.

Rear Elevation.



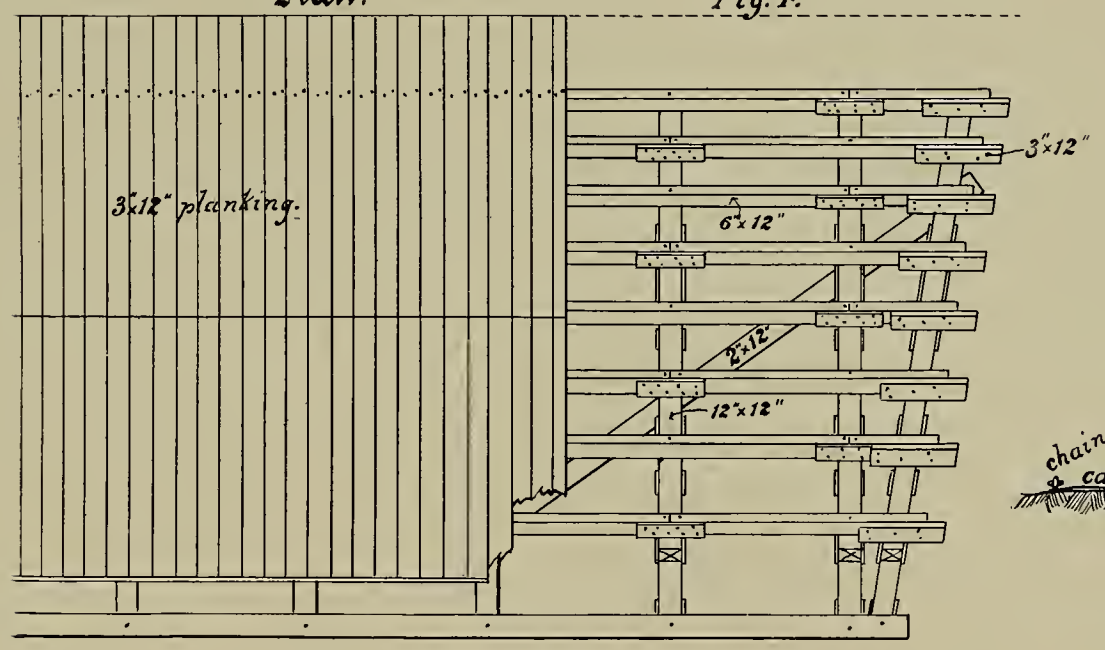
Scale.

Fig 2.



Plan.

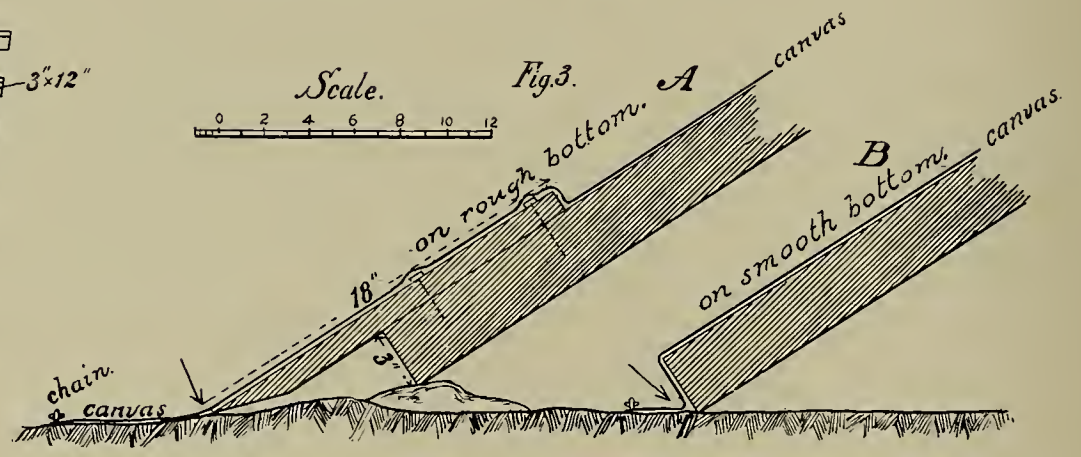
Fig. 4.



Section.

Scale.

Fig. 3.



to close the lower end of the lower lock of the Des Moines Rapids Canal. The dam was placed about 40′ below the lower mitre-sill, where there was a smooth rock bottom. The ends of the dam abutted against the flaring masonry walls of the lock approach. The dam was 96′ long and 15′ high. The framework consisted of thirteen triangular bents parallel (except the end bents, which were slightly flared out) and spaced about 8′ apart, connected by 9 longitudinal timbers, equally spaced along the longer inclined side of the bents, which had a slope when in place of one on one and one half. The entire structure might be likened to a roof, of which the connecting pieces were purlins and the longer inclined timbers on which they rested, rafters. The rafters and the sills, or bottom pieces of the bents, were of 12″ × 12″ timber. Five inclined struts of 8″ × 12″ timber, parallel to each other, transferred the pressure from the rafter to the horizontal sill. The timbers were cut as little as possible, so that they could be used for other work later. The struts were held in place by plank spiked on. The rafters and sills were each 24′ long. The end strut was placed between the outer ends of the rafter and sill. The purlins were bolted to each rafter at each intersection, by a $\frac{5}{8}$″ screw-bolt. At the toe of each bent a key of oak wood was placed, to prevent the rafter from slipping on the sill, and the rafter and sill were fastened together by an inch screw-bolt. The structure was braced diagonally lightly, so that it should not be distorted in moving, but so that the individual bents might settle solidly in place on the uneven rock bottom. The bents were framed and set up in the United States dry dock, $2\frac{1}{2}$ miles away, and the entire frame was towed to place, suspended between barges. The frame was sunk in position by placing on it between the purlins, one at a time, 60,000 lbs. of old rails. The sinking was kept uniform throughout. The purlins were then sheathed with 3″ plank, 16′ long, set accurately in juxtaposition, and against the bottom, by a diver, and spiked through the ends to the corresponding purlins. The lower spikes were driven by setting them lightly before the plank was placed, and then driving them home by an iron rod worked through a $\frac{3}{4}$″ pipe, from a barge moved below the dam. A second tier of plank 8′ long was then placed. The "roof" was then covered with a sheet of 12-oz. duck, 26′ wide, and 4′ longer than the dam. $\frac{1}{2}$″ chain was sewn continuously along the lower edge, as a sinker. The sheet was spread out under water by a diver. The edges extended out over the bottom and up the side of the wing walls. On the wing walls and the upper edge of the dam it was fastened by light cleats, nailed on. The diver saw that the sheathing-planks made a close fit along the bottom. Where irregularities in the rock prevented this, short pieces of boards with the lower end bevelled were nailed to the sheathing-plank and extended down to the rock. The dam proved very tight. The greatest head of water against it was 12′, but the engineer in charge thinks that it would have stood 25′ just as well. He also thinks that the tightness was assisted by the small quantity of mud held in suspension in the water, and that for clear water it would be advisable to coat the canvas with oil or other suitable material. For further particulars concerning this dam and the use of canvas for similar work, see "The Use of Canvas in Water-tight Bulkheads," by M. Meigs, vol. xxxi., Trans. Am. Soc. C. E., from which the above description was compiled.

Stock-ramming for Tightening Coffer-dams.—Where soft spots are found in the puddle of a coffer-dam, the dam can be tightened by this process. Stock-ramming as employed for tightening the coffer-dam of the St. Mary's Falls Canal lock is described as follows:

The plant used was (1) a 3″ pipe in short sections, coupled together, long enough to reach completely through the coffer-dam; (2) a rammer, which was a rod $2\frac{1}{2}$″ in diameter, enlarged for 3′ from its lower end to $2\frac{7}{8}$″ diameter, and long enough to extend through the pipe; (3) an ordinary pile-driver with a 1900-lb. hammer; (4) clay-cutters, hollow cylinders, 3″ high and a little less than 3″ in interior diameter, with handles, made from shovels, by cutting the blade to a proper length and then rolling it to the required size. The material used was clay in cylinders 1′ high and a little less than 3″ in diameter, punched from tempered clay with the cutters.

The pipe was first forced down to the bottom of the dam, and

about ⅛ of a cubic yard of clay driven down and rammed. It was then raised 10′ and the operation repeated, and so for a third time, when the surface was reached, making about 1 cu. yd. of clay to each hole. The apparatus was then moved about 5′ and the operation repeated, and so on until the dam was tight. The operation is said not to lift or crack the puddle, nor to strain the cribs to an appreciable extent. For further details and plates showing the apparatus in use, see the Rep. C. of E. 1892, pt. 3, p. 2405, and Plates 110 and 111.

LOCKS AND DAMS.

These necessarily vary markedly, according to the conditions in each case. A few typical works will be described to show the general character of this important class of public works.

Great Kanawha River Lock and Movable Dam No. 7.—This is one of a system designed to leave a clear river during flood stages, and to afford slack-water navigation, with a depth of 6′, during the low stages. The stone used in the work is selected Kanawha sandstone. quarried near the site. This stone has a crushing strength of 15,000 lbs. per sq. inch on bed and of 11,000 lbs. on edge, when crushed in 2″ cubes. The river-bottom consists of shingle and sand in thin layers over hard-pan and rock.

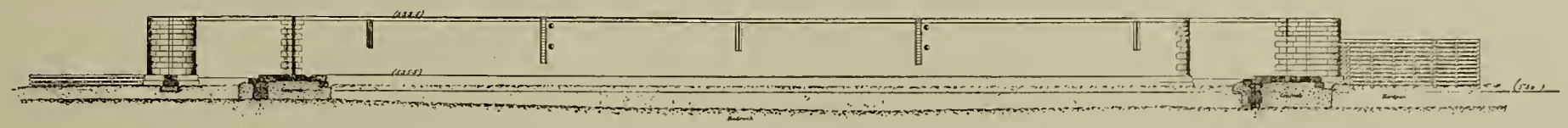
The lock is 411′ long from out to out of the masonry, and 342′ long between quoins. The width of the lock-chamber is 55′. It is filled and emptied through valves in the gates. The dam is a movable dam of the Chanoine type. The navigation pass is 248′ long, the weir 310′ long. A masonry pier separates the pass and weir, and the dam lies between the river wall of the lock and a stone abutment on the opposite bank. The dam is provided with a trestle service-bridge of the usual pattern, from which the wickets are raised and lowered with the aid of a winch. The lock-walls are faced with coursed ashlar.

Lock Masonry.—The whole space to be covered with masonry or concrete was excavated to the solid rock, and all loose or soft rock removed. Before placing the masonry the rock was first scrubbed clean and cut into good horizontal beds so that each stone should have a full bearing. The stones of the first course vary in height, but no stone has a rise of less than 8″. Wherever it was necessary, concrete was used to level up any unusual depressions in the bed-rock. All stone was required to be perfectly sound, to meet the tests for strength, and to weigh at least 150 lbs. per cu. ft. For the face-stones there were three classes of cutting, viz., fine cut or brush-hammered work, pointed face, and rock face.

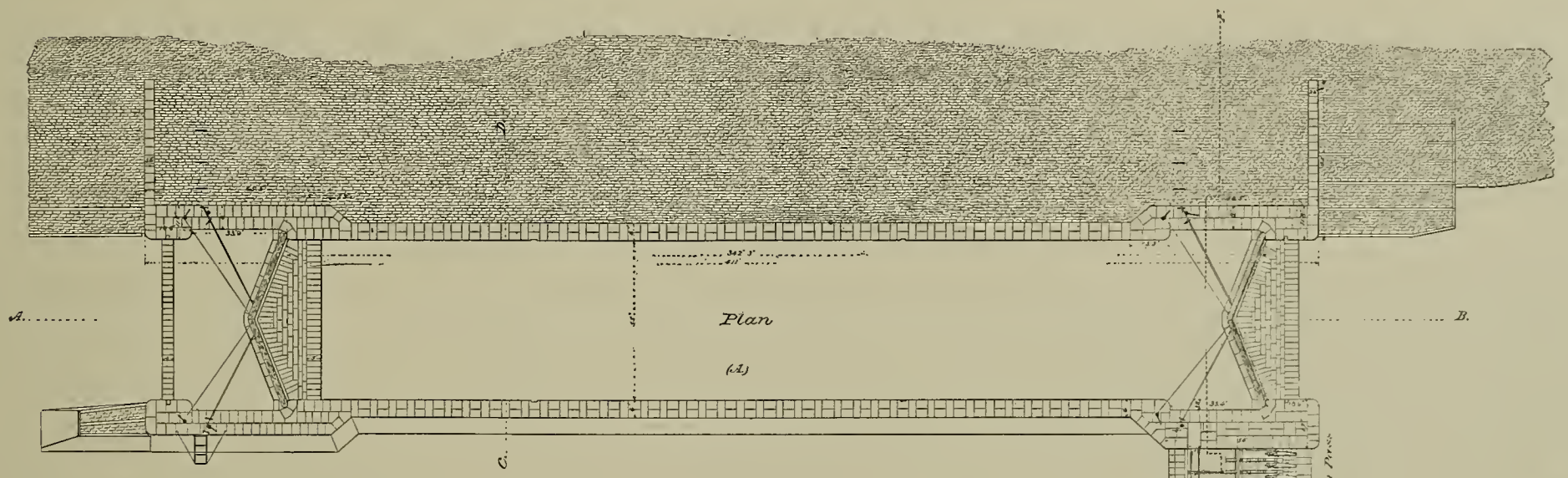
The mitre-sills are of selected stone, set on edge, carefully cut and shaped, and chiselled smooth to receive the cushion timbers. They are anchored to the bed-rock by wedge-bolts. The four cushion timbers are of selected white oak, planed and worked to the specified dimensions. The four pivot-stones are selected stones, carefully cut and placed. The quoins are also from selected stone, fine cut. The gate-bearings were chiselled smooth and the remainder of the exposed surface bush-hammered. The beds and vertical joints were truly pointed, and each stone was plumbed and set with ⅜″ joints. The coping is from selected stone, bush-hammered on all outer faces, and laid with ⅜″ joints. The exposed edges of the coping were rounded to a radius of 2″, and were dowelled with round iron set in Portland cement.

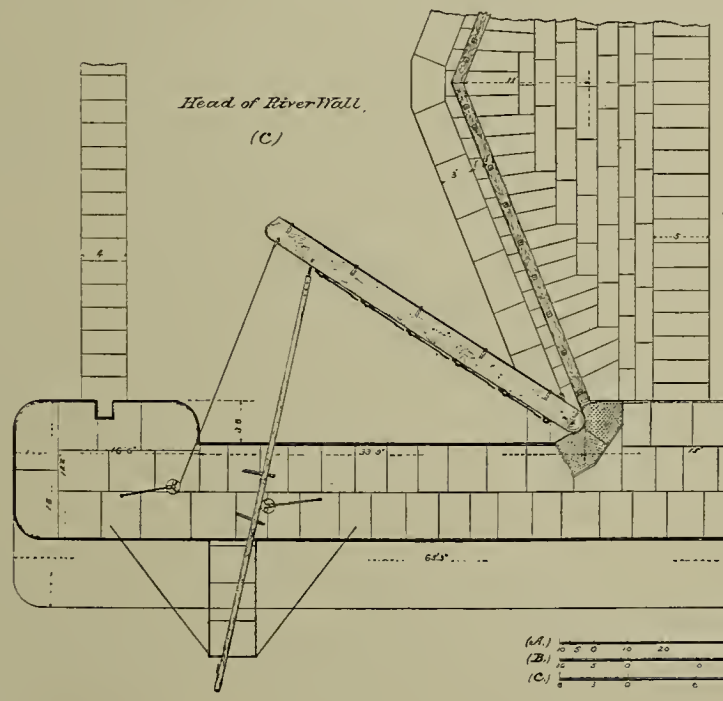
All stone specified as "cut stone" was bush hammered on the outer faces and set with ⅜″ joints. The vertical joints are full for 15″ from the face. In the "pointed-face" masonry the vertical joints are full for 12″ from the face. One fifth of the face of this class is composed of headers at least 4′ long. Stretchers have one fourth more bed than rise. Both bed and vertical joints were pointed down to fair, plain parallel surfaces, to lay with ½″ joints. Wherever "pointed face" joined "fine cut," a chisel-draught line 1¼″ in width was cut on the face, and the joints are ⅝″. "Rock-face" masonry was placed like "pointed-face" throughout. Wherever it joins masonry of a higher class, draught-lines were cut to correspond and the joints are ⅜″.

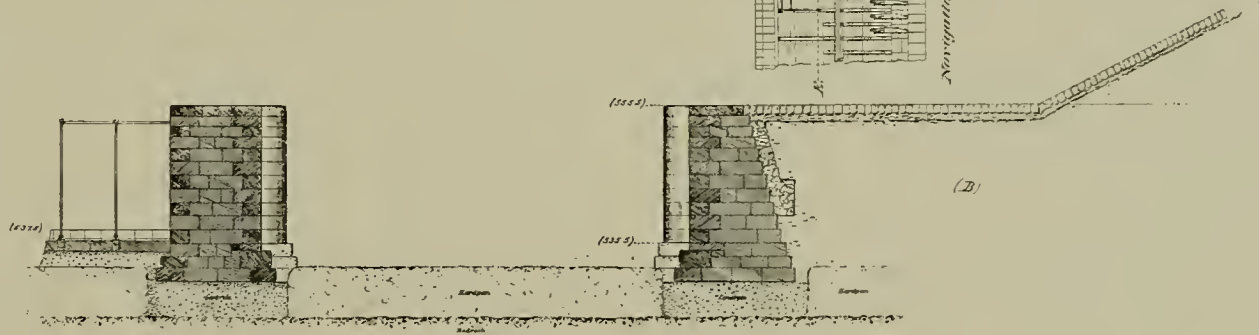
THE LOCK



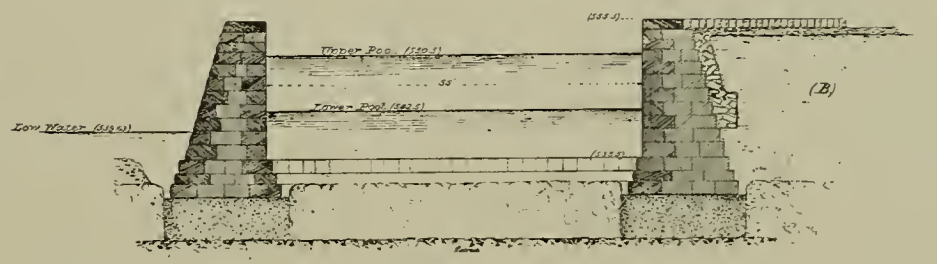
Section AB. and Elevation of Land Wall



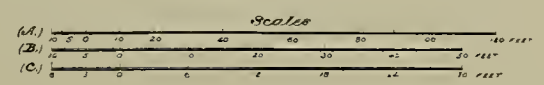




Section EF.



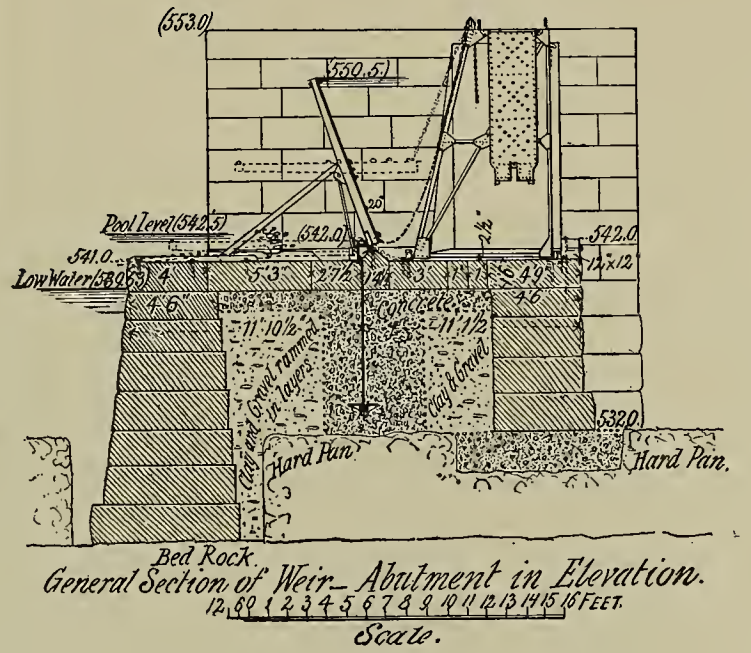
Section CD.



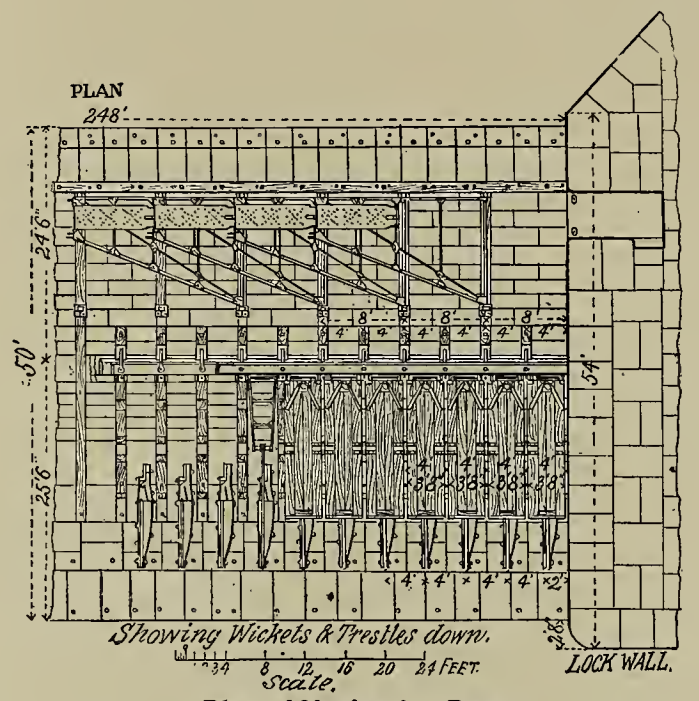
U. S. IMPROVEMENT GREAT KANAWHA RIVER. PLAN, SECTIONS, AND ELEVATIONS OF LOCK No. 7.

U. S. IMPROVEMENT GREAT KANAWHA RIVER. LOCK No. 7 DURING CONSTRUCTION.

PLATE XVIII.



General Section of Weir_Abutment in Elevation.

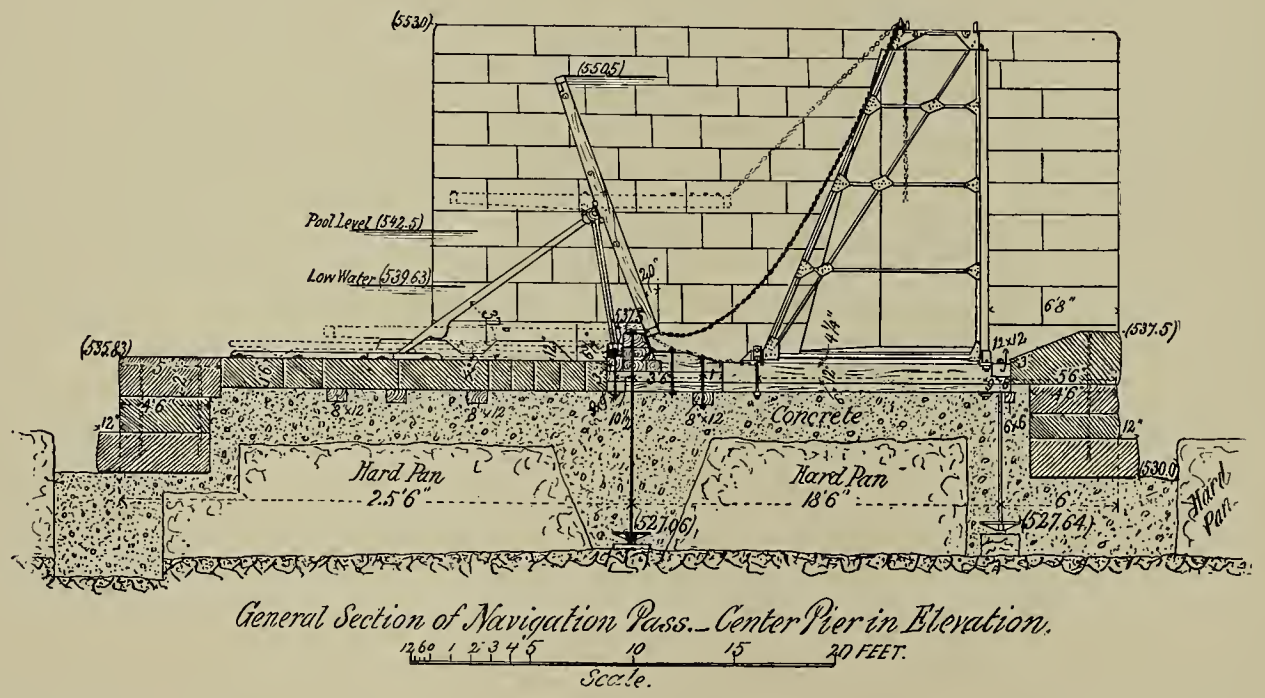


Plan of Navigation Pass.

U. S. IMPROVEMENT

GREAT KANAWHA RIVER.

LOCK AND DAM No. 7.

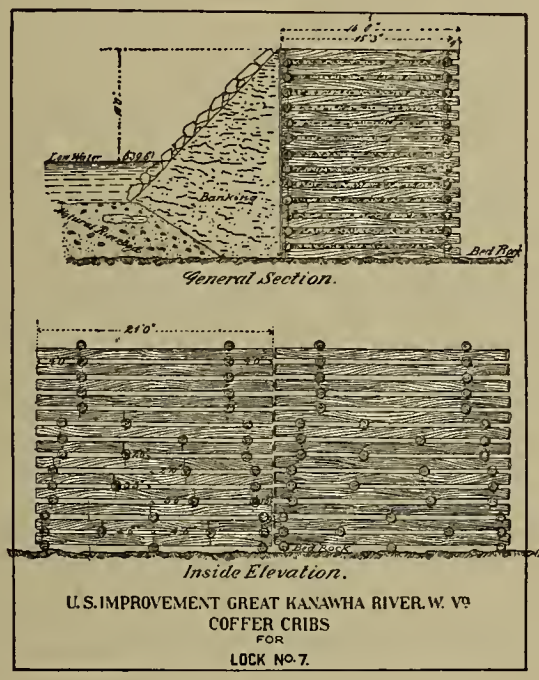


General Section of Navigation Pass._Center Pier in Elevation.

The backing of all the walls is of good-sized, vertical-sided stones. As a rule, each was shaped up and bedded, top and bottom, to correspond to the height of the face-stone before being placed on the wall. The bed-joints in the backing never exceed 1″ in thickness.

All stones were laid in horizontal courses, in full beds of mortar and settled in place with a wooden maul. Backing was laid in full

FIG. 8.



beds of mortar so as to bond and break joints thoroughly. The spaces between the backing-stones never exceed 8″ at the widest point. They were all filled solid with selected hammer-shaped stones and spalls laid in mortar.

In laying the masonry, the site for the stones and the stones themselves were thoroughly cleaned and moistened with a scrub-broom before the stones were set. The use of grout was prohibited. The bond of the stones is in no case less than 8″ All face-work was pointed as the work progressed, with stiff mortar of 1 sand and 1 cement, thoroughly hammered and finished.

Guard-cribs—Ends of Land Wall.—Permanent guard-cribs were built at the head and foot of each wall. These are of white oak, framed and driftbolted together and filled with stone carefully packed in by hand. The tops are covered with large well-shaped stones, pointed and set level with the top timbers. The ends of the land wall are joined to the solid earth of the bank by wing-walls of masonry. Puddle clay was placed at the end of and around the upper wing-wall.

Filling in Rear of Land-wall.—Loose stone was placed by hand back of the land-wall to form a drain which led out through a hole in the lower wing-wall. A level space was formed behind the land-wall and between the wing-walls by filling with suitable material, well tamped, to the level of the top of the walls. This space and portions of the slope of the bank were paved with rough-pointed stones, 15″ thick, resting on a 12″ bed of spalls. The slopes on the bank in the vicinity of the lock were protected with hand-laid riprap on spalls.

Dam.—The foundation of the navigation pass is 50′ wide. It consists of a bed of concrete resting on the solid rock and hard-pan, covered with the timber sill of the dam, the other timbers to which the dam irons are attached, and coping and paving stones. The top of the dam sill is 2′ below the level of low water. Beneath the sill and at the up-stream edge, the foundation is excavated to the rock, to afford a secure anchorage for the holding-down bolts of the upper trestle-leg-box timber, and of the sill. The thickness of the remainder is about 3′. The up- and down-stream edges are capped with large bush-hammered coping-stones, bolted down.

The foundation for the weir forms a low fixed dam with its crest 2′ above the level of low water. It is constructed like the navigation-pass foundation, excepting that there is a wall at the lower edge, reaching to the solid rock.

The pier between the pass and weir is of solid masonry, similar to that of the lock. It is 34.6′ long, 10′ wide, and has its top 16′ above low water. The abutment is of similar finish. It is joined to the bank with wing-walls, and has a long retaining-crib on its down-

stream face. The slopes of the bank in the rear are also paved for 50′ up-stream and 130′ down-stream.

Cement and Mortar.—The cement used for the mortar was Rosendale, standing the usual tests. The mortar was generally of 1 cement to 2 sand. The concrete was 1 cement, 2 sand, and such a quantity of broken stone that the mortar should form 48 per cent of the mass.

Wickets.—The wickets of the navigation-pass are 14′ $\frac{1}{8}$″ high, and 3′ 8″ wide, spaced 4′ from centre to centre. Their inclination from the vertical when standing is 20 degs. Their top edges, standing, are 13′ above the sill, and they lap the sill by 5″. Lying down they are just below the level of the sill. They have white-oak frames and pine panels. The weir wickets are 9′ 2$\frac{1}{2}$″ high, and 3′ 9″ wide. They are spaced 4′ between centres. In all other respects they are similar to the pass wickets. The irons for the dam were bought by the United States under a separate contract.

Lock-gates.—These are of white oak, built without heel or mitre posts. The main timbers pass from edge to edge of the gate, and the edges and middle are built up solid by filling-blocks. The parts are assembled with horizontal and vertical bolts and keys, and the spaces between the timbers are planked. The gates rest at the heel on steel gudgeons, and are held by top fastenings and anchors built into the masonry of the wall below the level of the coping. The upper fastening admits of easy adjustment in two directions. The lock is filled and emptied through valves in the gates, each leaf having five cast-iron valves hung horizontally in a wrought-iron frame. The valves are opened and closed by racks and pinions worked from the tops of the gates. The gates are handled by spars and capstans, each leaf being manœuvred from the top of the wall adjacent. The lock is filled and emptied for the maximum lift in about four minutes.

Cost of Labor.—Wages, per day: Foreman of laborers, $2; laborers, $1.50; steam-engineers, $2; carpenters (framing), $1.50 to $2.50; foreman of carpenters (one to six carpenters), $4; masons, $3.75; foreman for masons (one to five masons), $4; stone-cutters, $3.50; foreman for stone-cutters (one to thirty cutters), $4; quarrymen, $2; quarry laborers, $1.50; blacksmith, $2; quarry foreman, $3.

Labor Notes.—A quarry gang comprised 1 foreman, 5 quarrymen, 5 laborers, 1 blacksmith, 1 water-boy, 1 horse-power derrick.

1 foreman and 8 laborers can build, sheathe, and place 5 cribs in 4 days in the lock coffer-dam and 3 cribs in 4 days in the dam coffer-dam.

The transportation of the stone from the quarry to the stone-yard cost 50 cents per cu. yd.. exclusive of loading and unloading.

1 man can break by hand 2 cu. yds. of concrete stone per day.

1 foreman, 25 laborers, and 1 steam-derrick can make and place 50 cu. yds. of concrete per day.

1 stone-cutter can cut on an average 1$\frac{1}{8}$ cu. yds. of face and backing per day, working in Kanawha sandstone.

The stone-yard was across the river from the lock. Stone was taken from the yard to the lock on flats. The transportation-gang comprised 1 foreman, 5 laborers, and 1 horse-power derrick.

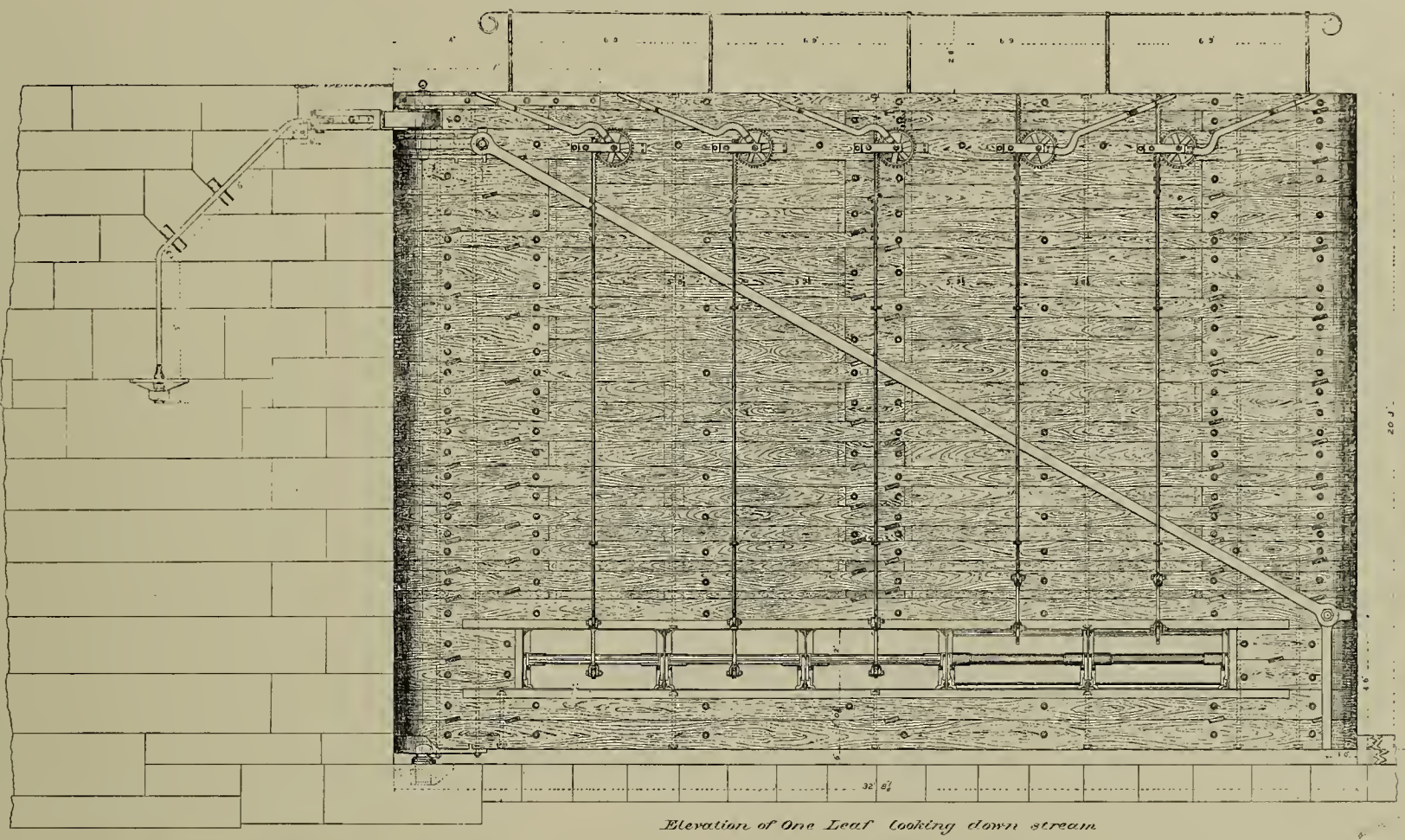
1 foreman, 8 laborers, 1 horse-power derrick and 1 steam-derrick, 3 masons and 1 water-boy, should lay from 40 to 50 cu. yds. of dimension-stone per day in the lock-wall, receiving it on a boat by the coffer-dam.

Cost of Materials.—White-oak timber in permanent construction, $27 to $30 per M; crib-logs, 2 cents per running foot; drift-bolts, 10″ to 12″ long, $\frac{3}{4}$″ square, 4 cents per lb.; Rosendale cement, $1.50 per bbl.; Portland cement, $3 per bbl.; sand, 60 cents per cu. yd.; puddle clay and sand for coffer-dam, 35 cents per cu. yd. in place.

The cost of placing the four leaves for the lock-gates was $200.

The cost of the pass wickets, for labor only, was $7 each; of the weir trestles, $4 to $5 each. The cost of framing the timbers for the navigation-pass was $25 per M.

Itemized Cost of Construction.—The cost of the various items of construction of the lock built under the contract was as follows:

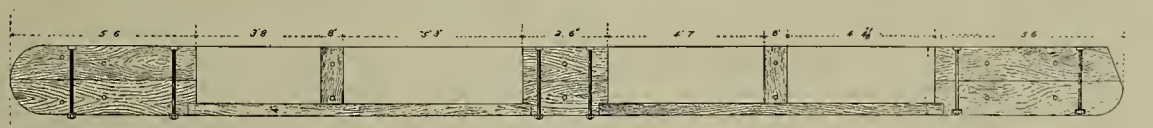


Elevation of One Leaf looking down stream

Section

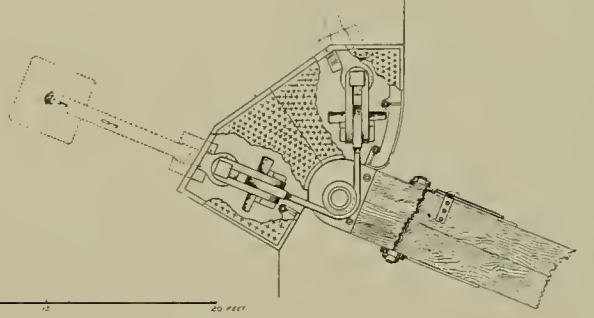
Section through Ends

Plan of Solid Beam showing Keys



Section between solid Beams

Plan Showing Valve Frame

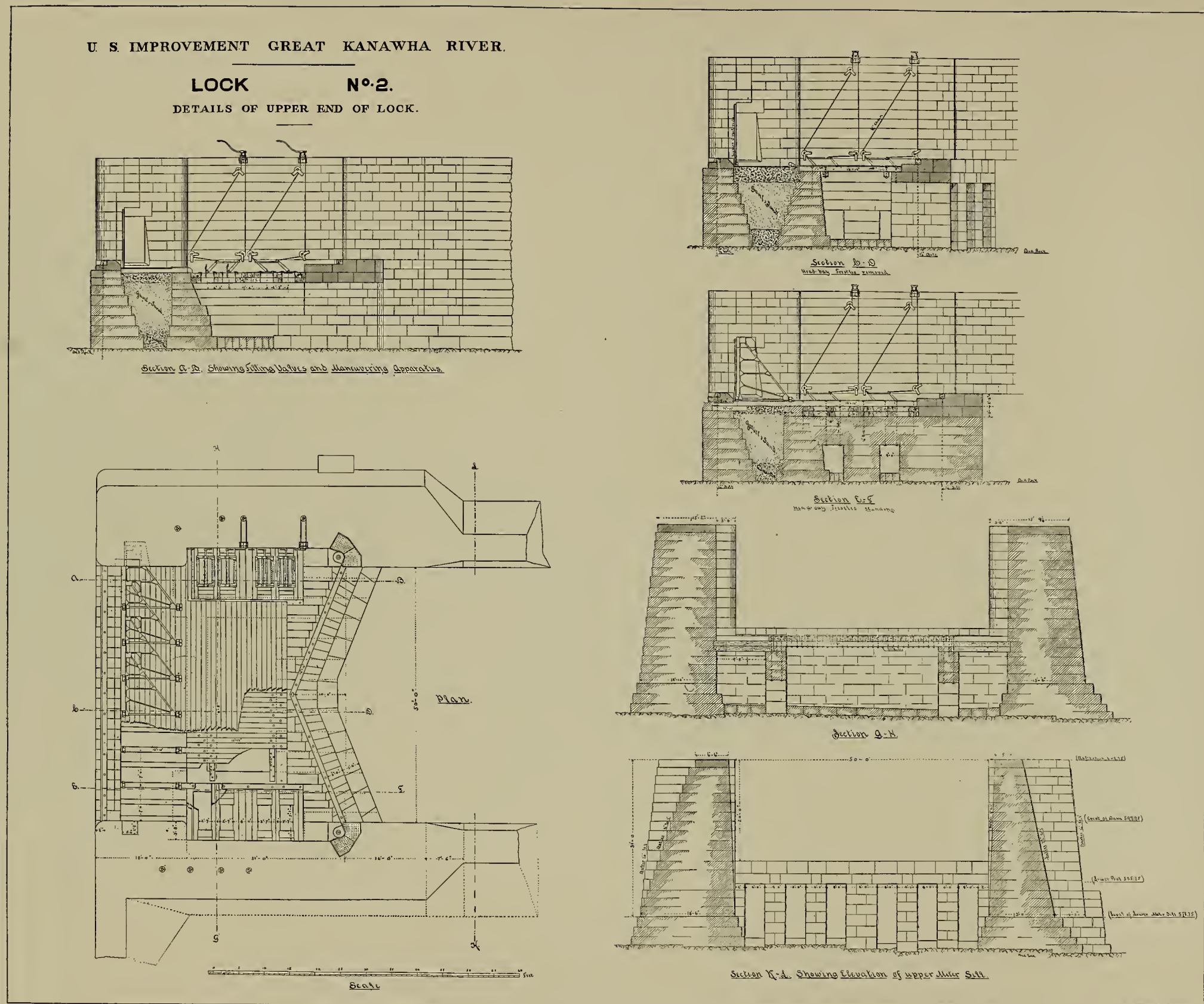


Upper Fastenings etc.

Scale

U. S. IMPROVEMENT GREAT KANAWHA RIVER. LOCK GATE AND ANCHOR IRONS, LOCK No. 7.

PLATE XX.



U. S. IMPROVEMENT—GREAT KANAWHA RIVER. LOCK No. 2. DETAILS OF UPPER END OF LOCK.

Grubbing and clearing, complete, $2000; crib-logs in coffer-dam, 53,903 lin. ft. at 28 cents per ft.; sheathing for coffer-dam, 34,870 ft. B.M. at $30 per M; coffer-dam filling, 7361 cu. yds. at 60 cents per cu. yd.; excavation, common, including dredging, 22,387 cu. yds. at 55 cents per cu. yd.; hard-pan excavation, 3064 cu. yds. at $1.25 per cu. yd.; rock excavation, 11 cu. yds. at $4.80 per cu. yd.; embankment, 11,031 cu. yds. at 50 cents per cu. yd.; puddling, 233 cu. yds. at $1.50 per cu. yd.; concrete, 600 cu. yds. at $5 and 2713 cu. yds. at $6.25 per cu. yd.; backing masonry, 5224 cu. yds. at $4.40 per cu. yd.; rock-face masonry, 2017 cu. yds. at $8.60 per cu. yd.; pointed-face masonry, 1836 cu. yds. at $9 per cu. yd.; cut stone, corners, etc., bush-hammered, 351 cu. yds. at $12 per cu. yd.; sills, 219 cu. yds. at $18 per cu. yd.; quoins, 76 cu. yds. at $25 per cu. yd.; coping, 377 cu. yds. at $25 per cu. yd.; riprap, hand-placed, 1987 cu. yds. at $3 per cu. yd.; paving 1171 cu. yds. at $5 per cu. yd.; stone filling, 3165 cu. yds. at $1.50 per cu. yd.; bolt-holes drilled in masonry, 1493 lin. ft. at 50 cents per ft.; timber, white oak, in guard cribs, etc., 60,150 ft. B.M. at $40 per M.

The aggregate of the contract was $160,630.24. The additional estimated cost to the United States will be: for irons built into the lock, $1093; for lock-gates complete, $7800.

The itemized prices paid for the dam, including the middle pier and the abutment, under the contract were:

Grubbing and clearing site, $500; crib-logs in coffer-dam, 79,307 lin. ft. at 20 cents; sheathing in coffer-dam, 52,766 ft. B.M. at $30; filling in coffer-dams, 10,865 cu. yds. at 60 cents; excavation, common, including dredging, 15,355 cu. yds. at 90 cents; excavation, hard-pan, 1819 cu. yds. at $1.80; excavation, rock, 8½ cu. yds. at $2.50; embankment, 1693 cu. yds. at 60 cents; puddling, 702 cu. yds. at $1.50; concrete, 3081 cu. yds. at $7.25; rock-face masonry, 2056½ cu. yds. at $10; pointed-face masonry, 462 cu. yds. at $13; cut-stone masonry, 103 cu. yds. at $15; sills, 300½ cu. yds. at $16; coping, 509 cu. yds. at $15; stone filling, 950 cu. yds. at $1.50; riprap, hand-placed, 833 cu. yds. at $2.50; timber in permanent construction, 104,620 ft. B.M. at $50; bolt-holes drilled in masonry, 4615 lin. ft., at 30 cents.

The aggregate of the contract was $116,669.38. The additional estimated cost to the United States will be for ironwork in anchorage and fixed parts of dam, $5500; ironwork in movable parts of dam, $12,700; woodwork of wickets, $2350; diving-apparatus and service-boats, $1300.

Lock and Dam No. 2, Great Kanawha River.—This is a lock and fixed dam, at present at the head of the Great Kanawha system.

Lock.—This is 377′ long from out to out of the masonry, 308′ long between quoins, and is 50′ wide in the chamber at the level of the sills. The top of the coping is 31′ above the lower mitre-sill and from 37′ to 39′ above the foundation on the solid rock. The upper mitre-sill rests on head-bay walls, 11′ above the lower sill. The maximum lift is about 12′. The lock is filled through 8 wrought-iron valves set horizontally in wrought frames in the platform of the head-bay and connected with the lock-chamber through culverts under the head bay, having 8 openings equally spaced under the upper sill. These valves are manœuvred in pairs with endless chains and capstans. The discharge-valves are in the lower gate, and are similar to those of Lock 7. The lock is filled and emptied at the maximum lift in four minutes. Steamboats without tows are locked through in either direction in from 6½ to 8 minutes. The lock-walls are founded on the bed-rock, and are similar to those of Lock 7. The gates are also like those of Lock 7.

Six heavy movable iron trestles are placed in the head-bay, as shown in Plate XX. These are anchored to the upper cross-wall, and are connected when standing by **I** beams. They are to form a support for a dam in case of accident to the gates, or whenever it might be needed. The temporary dam will consist of inclined scantlings resting against the upper cross-sill and the **I** beams, or of plank placed horizontally across the lock.

Dam.—This is a fixed dam of timber cribs filled with stone, resting on the bed-rock. Its length is 524′, width at foundation 38′, and

height from foundation 26′. The down-stream face from the low-water level is built in two steps, 16′ and 11′ wide. The up-stream face (back) is vertical to within 3′ of the top, from which point it slopes up to a crest, with a slope of 3′ on 11′. The bed-rock is 12′ to 14½′ below extreme low-water mark.

Construction Methods.—The lower tier of cribs was first sunk entirely across the river. These were 17′ long, 38′ wide, and from 14½′ to 17′ high, the height in each case being such as to bring the tops of the cribs to a uniform height 2½′ above low water. The cribs are of white oak, with 12″ × 12″ longitudinal timbers (parallel to the axis of the dam) with 9″ × 12″ transverse timbers, gained into the longitudinals for a depth of 3″. All of the timbers are driftbolted together at the intersections. The cribs are so built that when in place a vertical tongue in one fits into a corresponding groove in the other. The tongue is formed by extending the middle longitudinal timbers of each alternate crib 4′ 8″ beyond the outer transverse timbers on each side, and the groove, by replacing in the other cribs the single tongue-timber by two timbers which extend beyond the outer transverse timbers 3′ 6″, and which are spaced far enough apart to allow the opening between them to be faced with plank and to afford room between the plank for the tongue. The lower course of the tongue-cribs is formed of five longitudinal timbers, the outer ones 24′ long, the next on each side 19′ long, and the middle or tongue timber 27′ long. On these are placed the transverse timbers, the outer ones 38′ long, 3′ 6″ from the ends of the longitudinals, and a middle timber, in two pieces, each 21′ long, which lap on the tongue-timber. The projecting ends of the outer longitudinals are braced back against the ends of the next timbers, just outside the outer transverse timbers, by 3″ × 6″ struts. The courses alternate until the crib is the required height, the top course being of transverse timbers. The groove-cribs are exactly like the others, excepting that the single-tongue timber is replaced by the two longitudinals which form the groove.

This substructure of cribs is held together by a single course of 9 longitudinal timbers, made continuous for the length of the dam, and bolted to the cribs. The next course of 9″ × 12″ timbers is built solid for 16′ from the down-stream face, to make the floor of the first step. On this substructure is built a continuous crib, 22′ wide, up and down stream, and 5′ 3″ high, with the up-stream face vertically over the up-stream face of the substructure. On this in turn is built the triangular crib which forms the crest and up-stream slope of the dam. The upper step is covered solidly with 9″ × 12″ timber, transverse, and the top slope with 3″ plank. The openings in the crib are packed with stone, and dredged material is banked against the up-stream face.

One end of the dam is against the outer wall of the lock. At the other end is a masonry abutment, running well back into the bank, with a retaining-crib below. The total cost of the dam and abutment was $104,328.54. The itemized cost per unit under the contract was as follows:

Itemized Cost.—Grubbing and clearing site, $1500; excavation, common, 38,445 cu. yds., 75 cts. per cu. yd.; excavation, rock, 199 cu. yds., $1.50 per cu. yd.; embankment, 7872 cu. yds., 35 cts. per cu. yd.; puddling, 418 cu. yds., $1 per cu. yd.; rock-face masonry, 1160 cu. yds., $9.50 per cu. yd.; coping, 31 cu. yds., $16 per cu. yd.; stone filling, 15,333 cu. yds., $1.55 per cu. yd.; hand-placed riprap, 112 cu. yds., $2.50 per cu. yd.; paving, 455 cu. yds., $4 per cu. yd.; timber in permanent construction, 991,773 ft. B.M., $30 per M; iron in place, 67,755 lbs., 5 cts. per lb.

Davis Island Lock and Dam.—This is the first of a system of locks and dams designed to provide slack-water navigation on the Ohio River during low stages and open navigation during high stages. It is situated 5½ miles below Pittsburg, and its pool forms the harbor of Pittsburg.

Lock.—The lock is placed on the north side of the river. It is 600′ long between gates, and 110′ wide. The walls are of masonry, resting partly on rock and partly on compact gravel, about 15′ below the level of the gate-sills. From the bed to 2½′ below the datum-plane (level of gate-sills) they are of concrete. Above this reference they are

U. S IMPROVEMENT

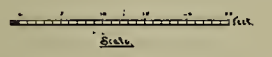
GREAT KANAWHA RIVER.

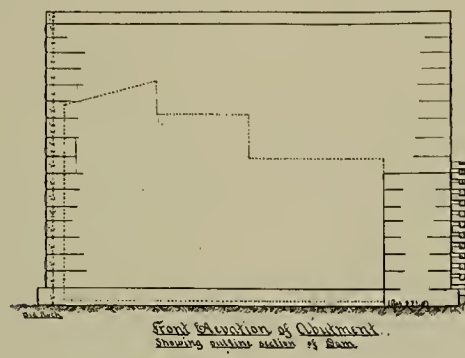
DAM N°. 2.

DAM, SHORE ABUTMENT

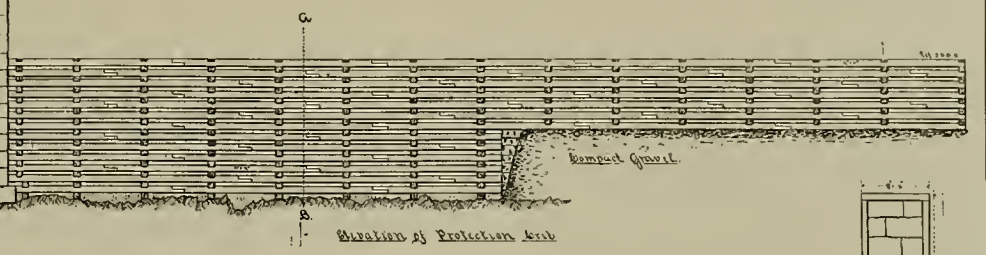
AND

PROTECTION CRIB



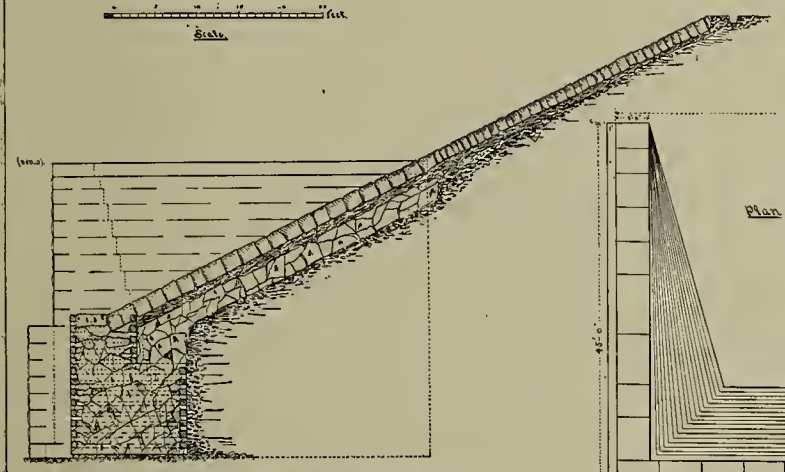


Front Elevation of Abutment.
Showing outline profiles of Dam.

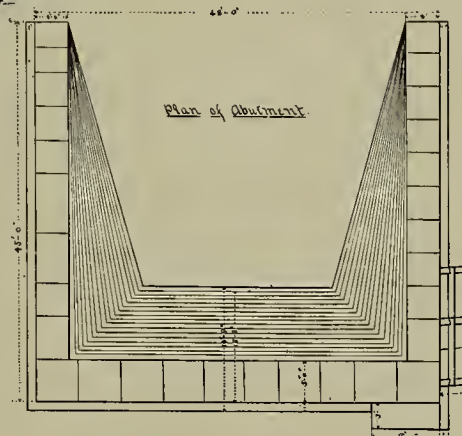


Elevation of Protection Crib

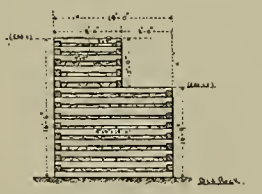
Abutment & Crib.



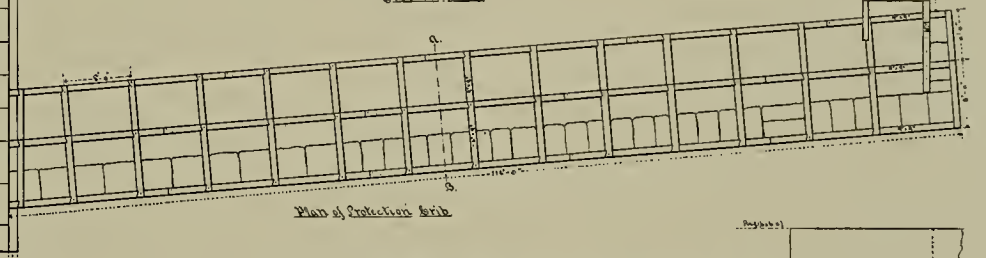
Section through Protection Crib Pasing and Hand placed Riprap Down stream Wing of Abutment in Elevation.



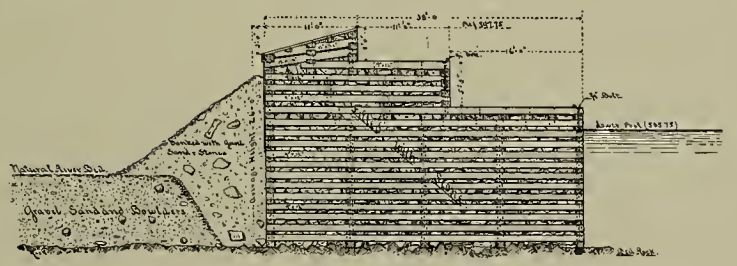
Plan of Abutment.



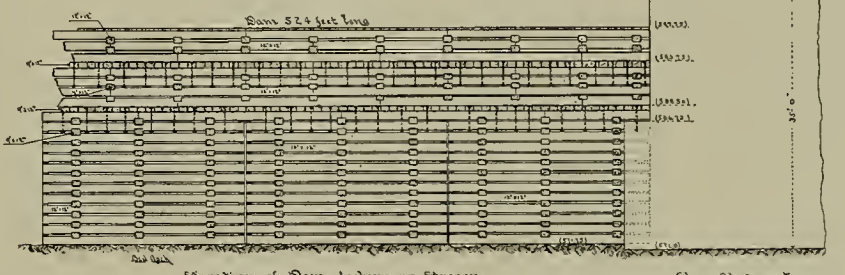
Section A B.



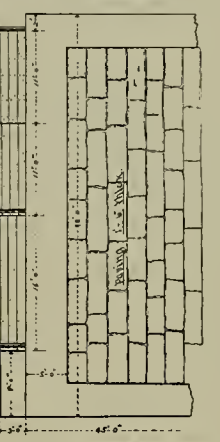
Plan of Protection Crib



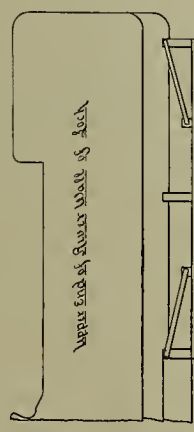
General cross section through Dam.

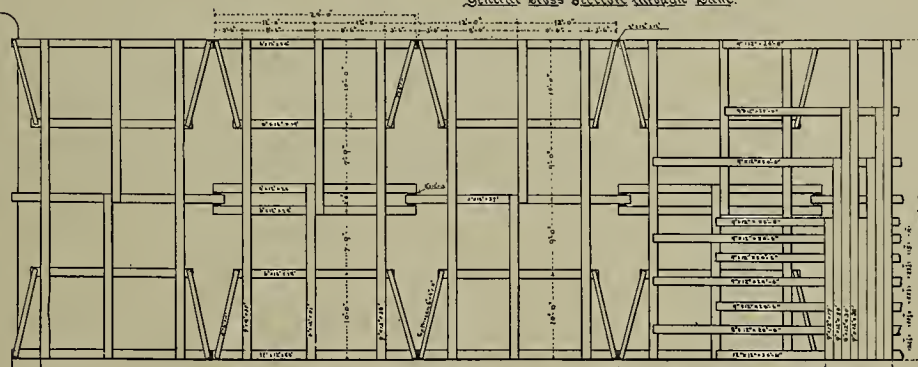


Elevation of Dam, looking up Stream.



Shore Abutment.

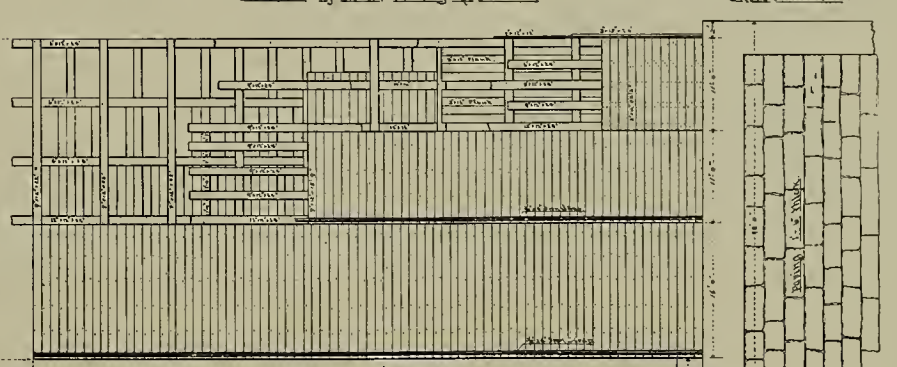




Bottom of Crib, Showing interlocking at Center.

Arrangement of Joints and Spacing of Timbers under Lower Apron.

Lower Apron Timbers.



Timbering on top of Lower Apron and under the Eleven Ft Apron

Timbering on top of Eleven Ft Apron.

Plan of Dam

U. S. IMPROVEMENT—GREAT KANAWHA RIVER, DAM No. 2

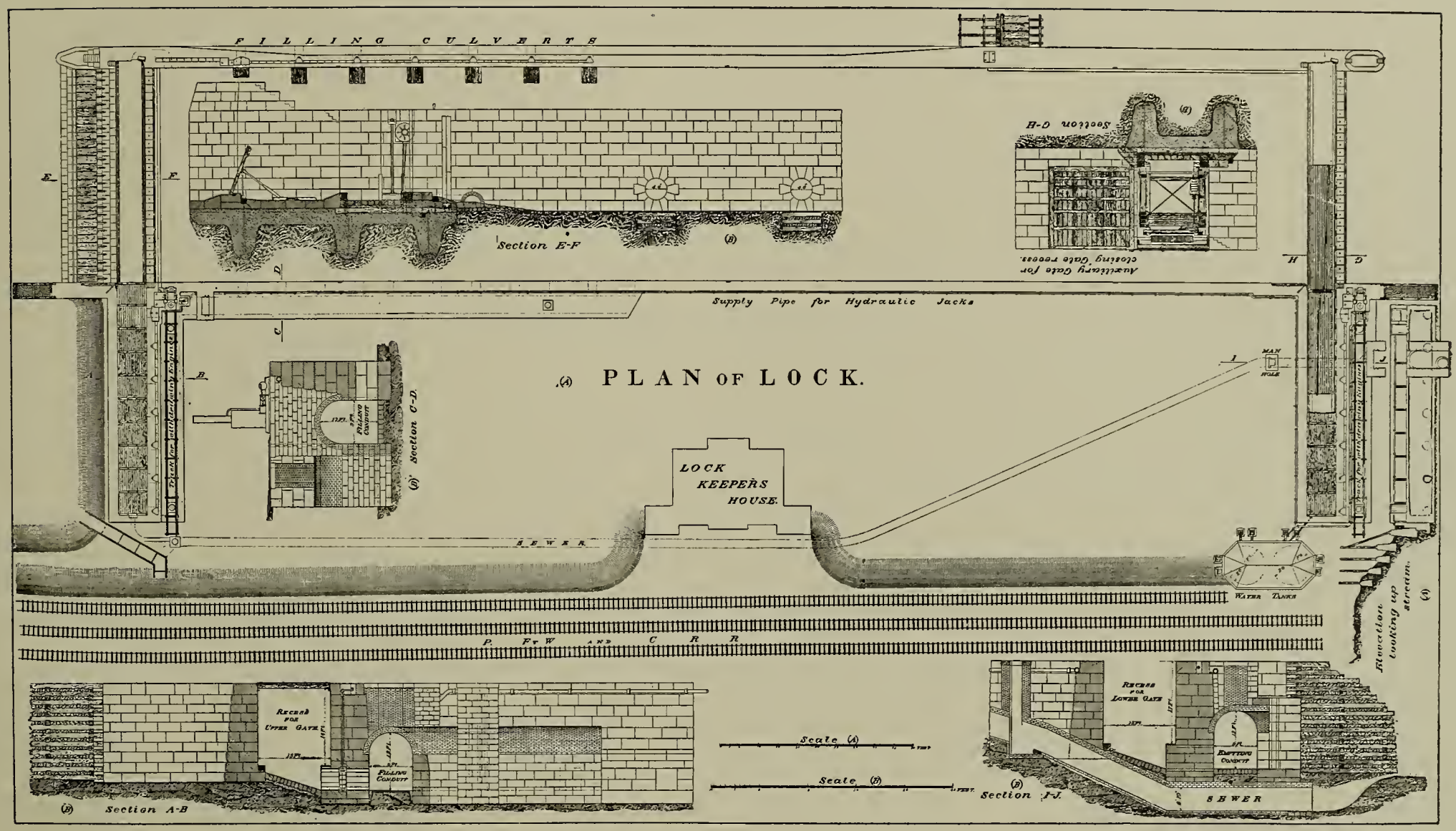
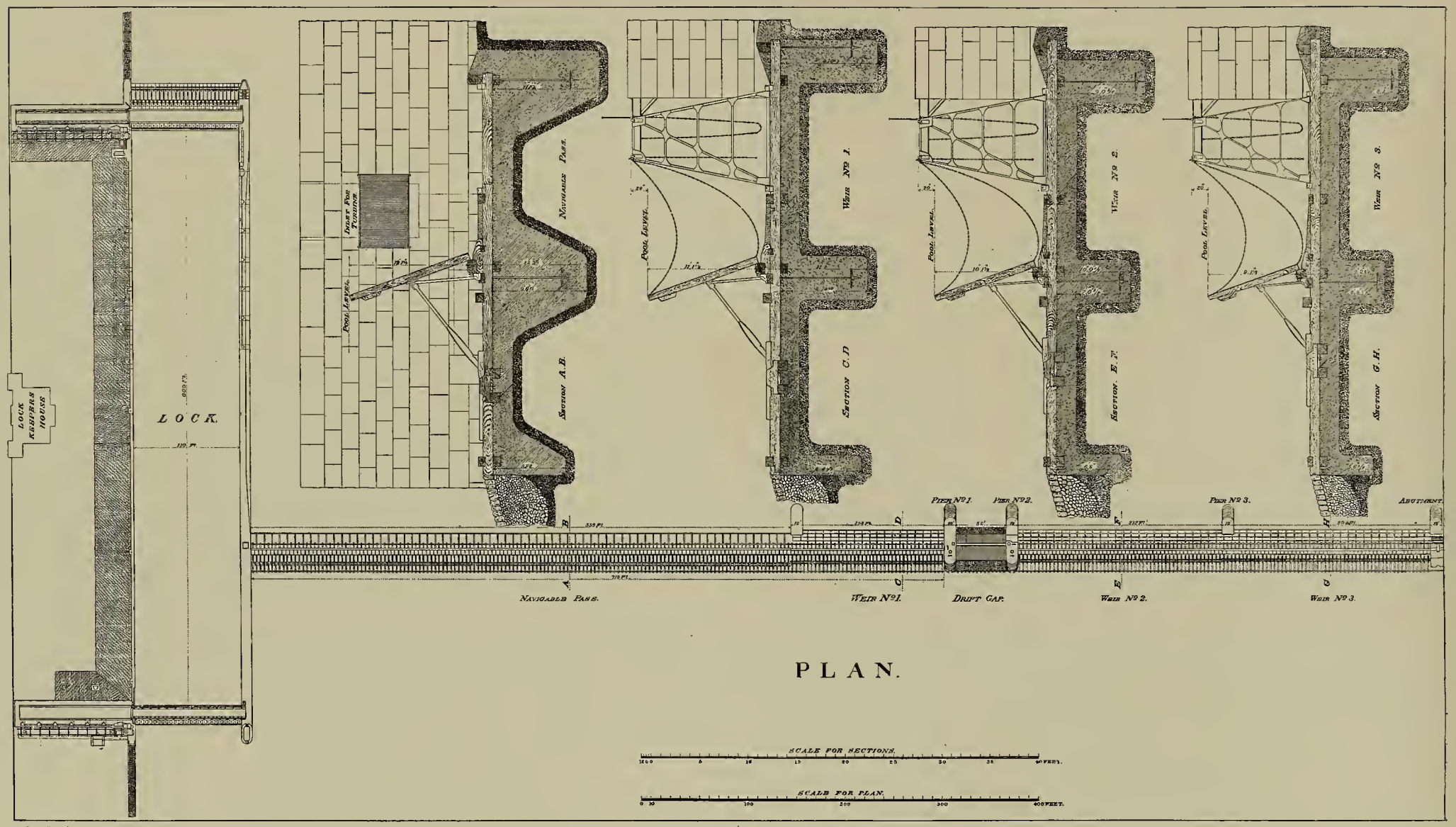

FILLING CULVERTS
Section E-F
Section G-H
Auxiliary Gate for closing Gate recess.
Supply Pipe for Hydraulic Jacks
(A) PLAN OF LOCK.
Section C-D.
LOCK KEEPERS HOUSE.
SEWER
WATER TANKS
Elevation looking up stream.
RECESS FOR UPPER GATE
FILLING CONDUIT
Section A-B
Scale (A)
Scale (B)
RECESS FOR LOWER GATE
EMPTYING CONDUIT
Section I-J.
SEWER

PLATE XXIII.

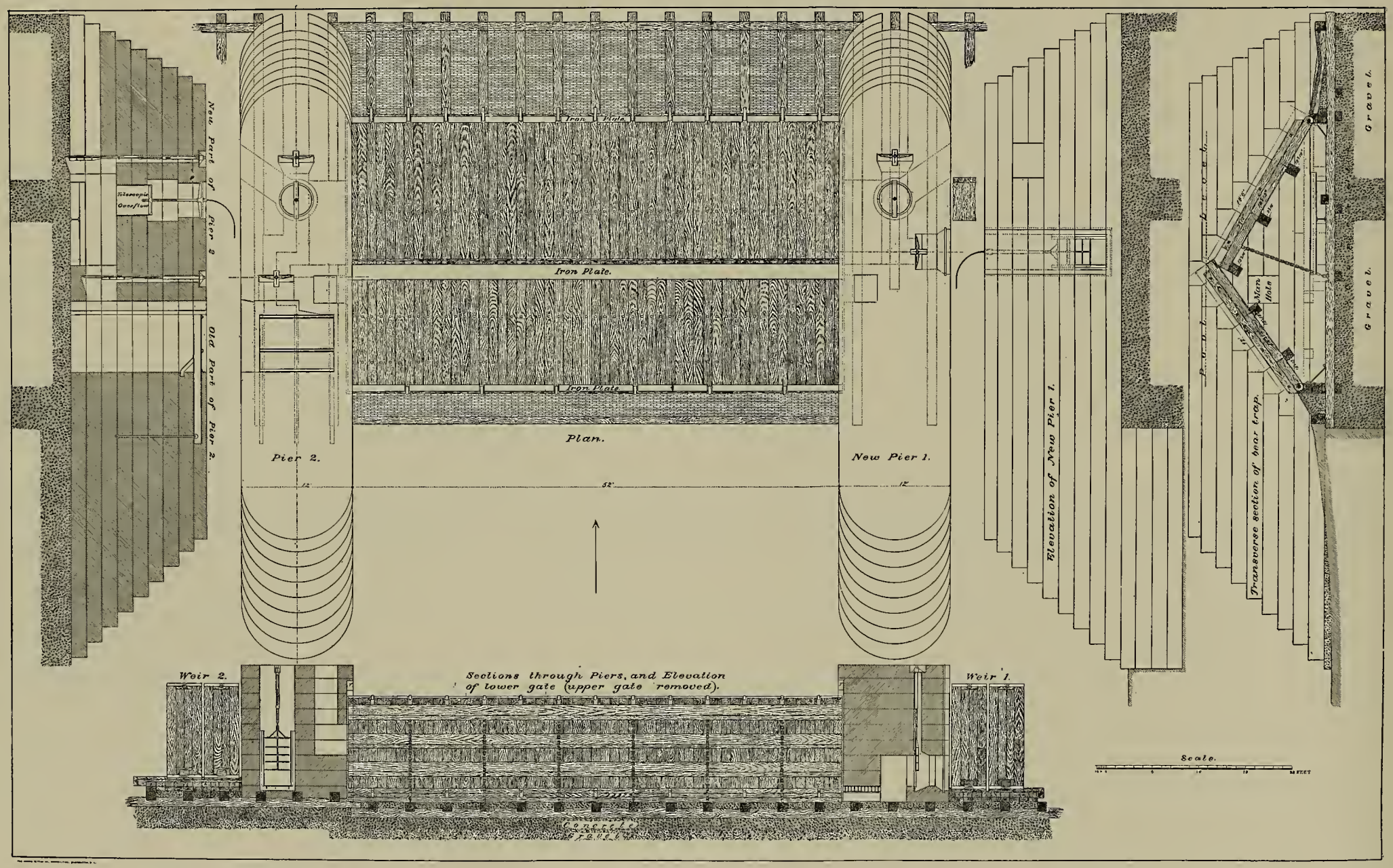
OHIO RIVER—DAVIS ISLAND DAM.



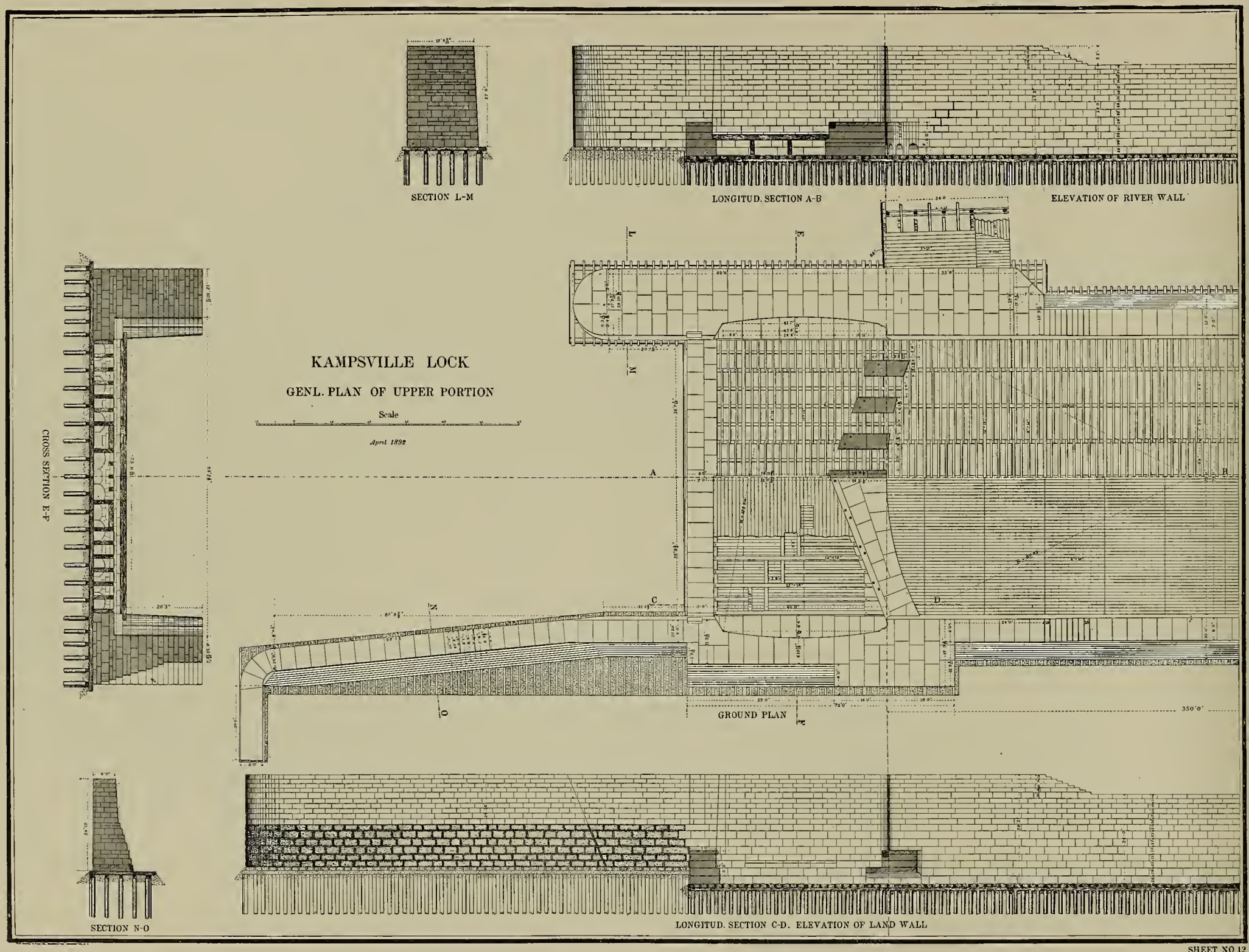
PLAN OF LOCK AND DAM AND SECTIONS OF DAM AND FOUNDATIONS.

PLATE XXIV.

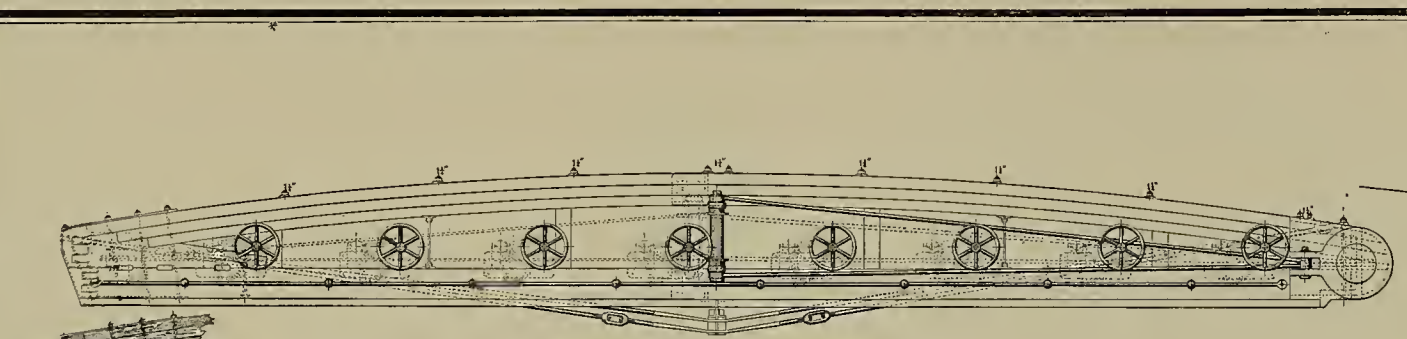
OHIO RIVER—DAVIS ISLAND DAM.



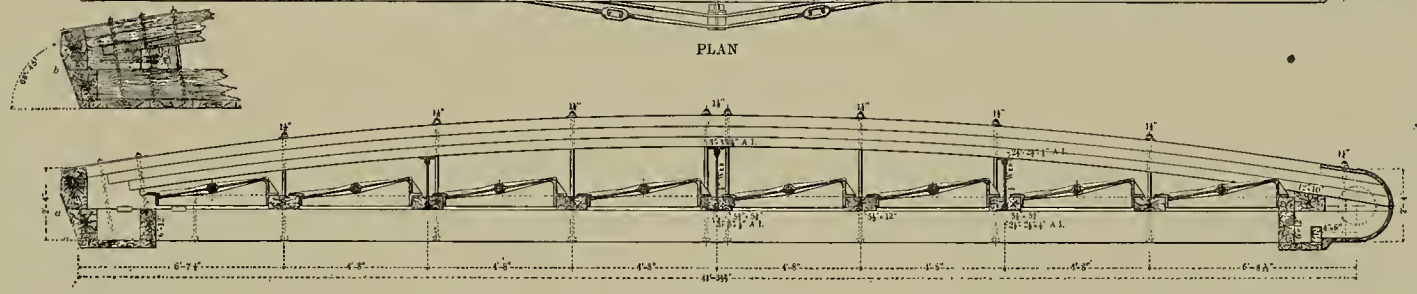
DRIFT-GAP WITH BEAR-TRAP GATES.


SECTION L-M
LONGITUD. SECTION A-B
ELEVATION OF RIVER WALL
KAMPSVILLE LOCK
GENL. PLAN OF UPPER PORTION
Scale
April 1892
CROSS SECTION E-F
GROUND PLAN
SECTION N-O
LONGITUD. SECTION C-D. ELEVATION OF LAND WALL

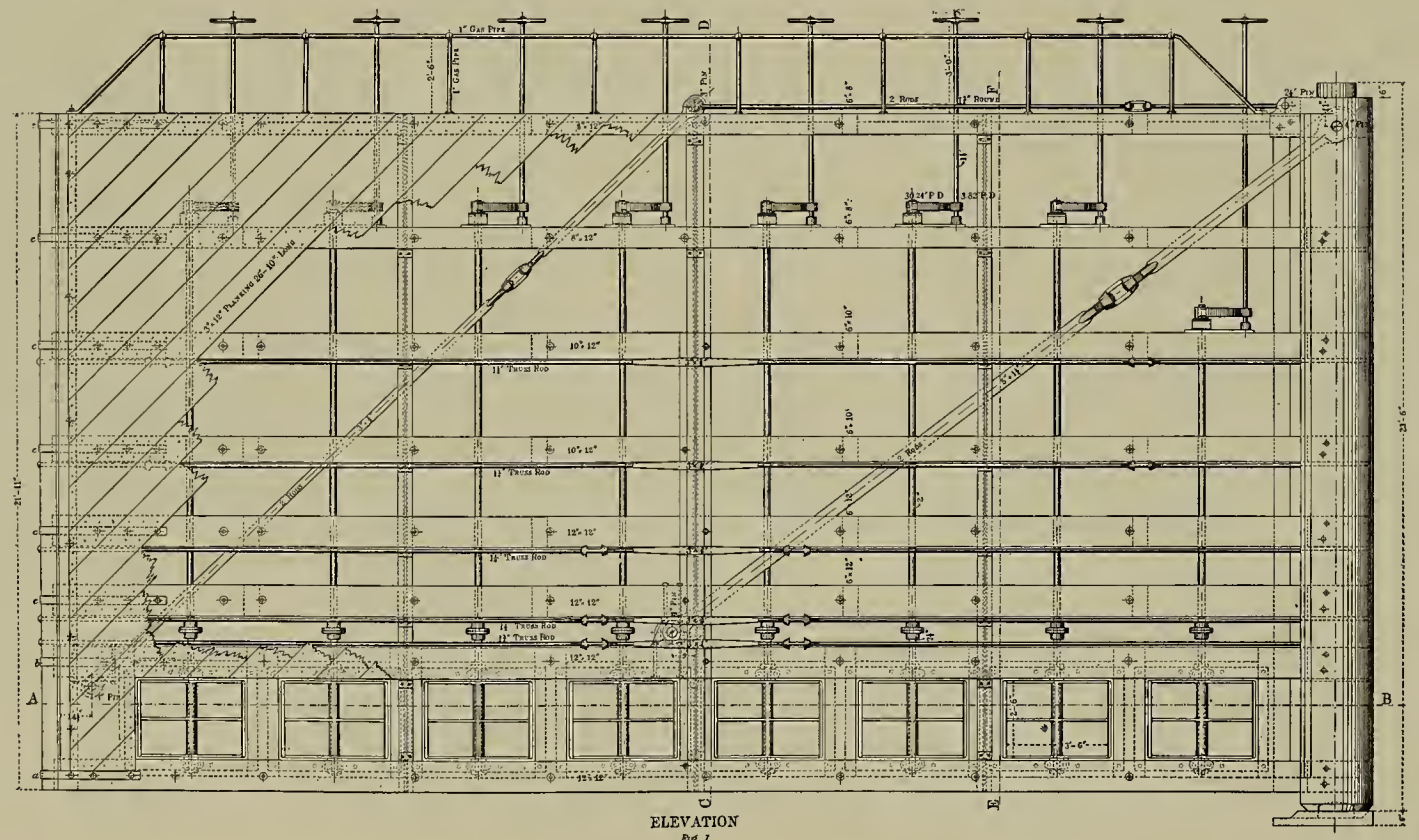
SHEET NO 12



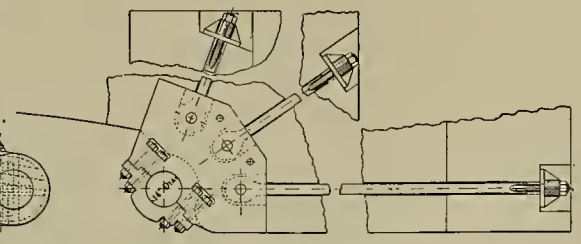
PLAN



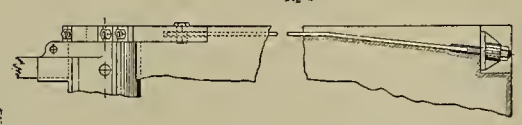
Section : A-B.



ELEVATION
Fig. 1

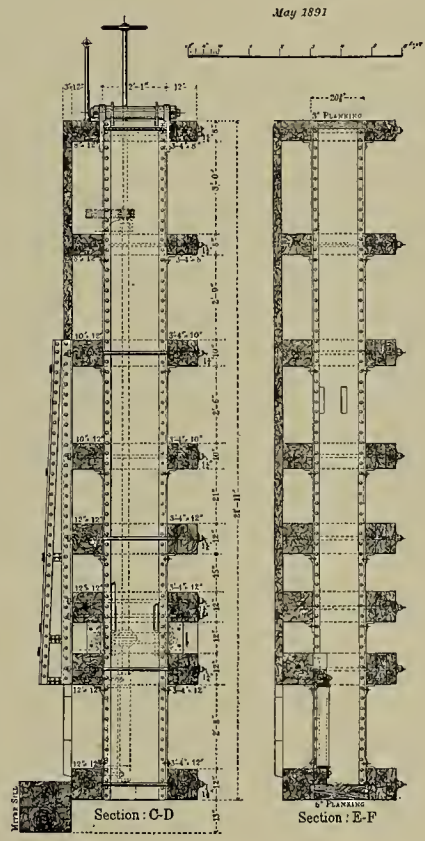


GATE ANCHORAGE
Fig 2



KAMPSVILLE LOCK
LOWER GATE

May 1891



Section : C-D

Section : E-F

of rubble and cut stone, Their tops are 17′ above the gate-sills. The lock is emptied and filled through culverts arranged as shown in Plate XXII. Valves in the gates can be used for this purpose also. The culvert valves are worked by hydraulic jacks, supplied from water-tanks with a head of from 44½′ to 60′. The tanks are filled by means of a pump in the river lock-wall, which is operated by a 25″ turbine-wheel, driven by the head of water created by the dam. A movable dam is placed across the lock in the head-bay, which can be used to close the lock when desired.

Gates.—The lock-gates are of a novel type. Each is a single leaf, which is rolled into place end on. The gate recesses, into which the gates are rolled when the lock is opened, are 120′ long, and extend shoreward from the land-wall. In general construction, each gate is a rectangular parallelopipedon, 14′ 6″ high, 13′ 7″ wide, and 118′ long, the edges of which are heavy timbers, and the sides, braces and ties. The top side is a heavy Howe truss. The down-stream face is sheathed, so as to be water-tight. The top of the gate is 14′ above the top of the lower sill. It is hung between the two sills, and rests on 28″ wheels, which run on tracks on the sills. Below the sill tops, both faces are provided with horizontal friction-rollers, which work against the inside faces of the sills. The gates are moved by steam-power.

Dam.—This consists of a movable dam, 1223′ long, of the Chanoine type, extending from the lock river-wall to Davis Island, and a fixed dam across the secondary channel south of Davis Island. The movable dam is divided into a navigation-pass, 559′ long; a drift-chute, 52′ long, closed by a bear-trap dam; and two weirs, 212′ and 216′ wide respectively, with sills 2′ and 3′, respectively, above the sill of the pass. The details of the dam and foundation are shown in Plates XXIII and XXIV. The wickets of the pass are handled from a boat. The weirs are provided with service-bridges.

Illinois River Improvement, Lock-and-dam at Kampsville.—At the site of this lock the bed of the river consists of mud and soft clay overlying sand to a depth of 20′ below low-water, where a firmer foundation is found. The natural low-water depth was 3′. The dam is fixed, 1200′ long, and has its crest about 7.4′ above the low-water level. The lift of the lock is 7.4′.

Lock.—The coffer-dam for the lock was of the type used at Davis Island dam. No coffer-dam was required for the dam. The length of the lock from quoin to quoin is 350′, and the width of the chamber at the level of the lower mitre-sill is 75′. The height of the walls is 24′. The upper sill is 7′ 3″ above the lower. The entire lock rests on a grillage supported by piles. This foundation extends about 2′ outside the outer lines of the walls on all sides, and is bounded by sheet-piling. The piles are in longitudinal rows, and in the rows are spaced 2′ apart. Under the walls the rows are 4′ apart, under the head-bay 5′, and under the lock-chamber and tail-bay 10′. The rows are capped with 12″ × 12″ white-oak timbers, and on these are transverse timbers 6″ × 12″, excepting each eighth timber, which is 12″ × 12″. The spaces between the grillage-timbers were excavated and filled with concrete to the level of the tops of the transverse timbers. The head-bay is floored with 2″ pine plank, and the filling-valves are placed in it, under a grating. These open into culverts, separated by bulkheads, which discharge through openings equally spaced across the upper lift-wall. The lock is emptied through valves in the lower gate. The gates are of wood and iron, with anchorages below the level of the coping. The walls are of coursed ashlar masonry, backed with concrete.

Dam.—This was built without the use of a coffer-dam, following a method which was first used in the construction of the La Grange dam in the Illinois River in 1889. The dam is of earth, backed by sheet-piling, supported by pile-bents. The crest of the dam is directly over the line of sheet-piling. The water wastes across the entire length, flowing after it crosses the crest over, first, an inclined plank apron 24′ wide, then over a horizontal apron, 10′ wide, and finally over a bed of stone 16′ wide, to the level of the natural bottom. The aprons are supported on the caps of the pile-bents. The space

under the aprons and between the piles is filled with stone riprap. The details of construction are shown in Plate XXVII.

The area to be occupied by the pile and stone work was first excavated to a depth of 3′. The round piles are in bents of five piles, perpendicular to the crest. The bents are spaced 6′ apart, and the intervals between the piles in each bent are 7′ 6″, excepting the down-stream interval of each bent, which is 9′. The up-stream pile of each bent is on the line of the crest. Each bent is capped in two sections. The first four piles are cut off so that the top of the up-stream pile is 7′ above low-water level, and the tops of the remaining three on a line inclined down-stream from the top of the up-stream pile with a slope of 1 on 3. These four piles are connected by two inclined stringers of 4″ × 12″ timber, gained in on each side of the piles, and with their tops even with the tops of the piles. Immediately beneath the lower ends of these stringers is a second pair placed horizontally, to connect the fourth and fifth piles. The top of the fifth pile is cut off flush with the tops of the horizontal stringers. Cross-timbers 3″ × 8″, spaced 3′ 9″, are bolted to the inclined stringers, and covered solidly with a floor of 4″ plank. The horizontal stringers are covered solidly with 4″ plank, and on this is placed a solid floor of 2″ plank.

Against the up-stream face of the upper pile of each bent is bolted two waling-strips of 10″ × 12″ timber, one immediately beneath the other, and with the top of the upper strip flush with the top of the piles. Immediately beneath these are five courses of 3″ × 10″ planks, placed horizontally and bolted to the piles. A line of Wakefield sheet-piles is driven immediately above the upper line of piles, with their tops against the lower plank course, to which the sheet-piles are spiked. The top of this line of piling is slightly above the low-water level. Immediately in front of and against this line a second line of Wakefield piles of the same dimensions is driven. The top of this second line is even with the upper edge of the inclined floor or apron, and forms the crest of the dam. This row is bolted to the waling-strips. In the rear of the line of sheet-piling and beneath the aprons is stone filling, extending 16′ down-stream from the lower line of the pile-bents. Earth is filled on the up-stream side, beginning about 44′ up-stream and sloping up to the crest. The upper half of this slope is paved with heavy hand-placed blocks of stone set on edge. The sheet-piling used was the "Wakefield triple lap," made of 2″ × 12″ × 16′ oak, fastened together with 14 wrought spikes, $\frac{5}{16}'' \times 6\frac{1}{2}''$, driven through and clinched. The sheet-piles were driven with an ordinary friction-hoist pile-driver, with a 3500-lb. hammer. The most satisfactory work was done with a hammer drop of 3′ to 4′, with strokes delivered as rapidly as possible.

The round piles were first driven, arranged as shown in the plate; and the up and down stream and the lower front wales were bolted on, rubble being deposited as rapidly as possible around the piles to prevent scour. The lower row of sheet-piling was then driven, with its top just below the low-water surface, and the earth filling placed against its up-stream face even with its top. The upper part of the face of the dam was then planked, and the second row of sheet-piling driven. The remaining rock was carefully packed in place, and the framing and the remaining fill above the dam completed. The work was done during low water, and while being carried on, the river flow was taken through the lock, the level of the water in the upper pool being regulated by the gates and valves.

Abutment.—This is of masonry, on a foundation similar to that for the lock-walls. It is L-shaped, with arms 6′ thick and 40′ long, one along the bank, and the other extending into the bank from the down-stream end. The tops of the walls are 16′ above low water. The bank is revetted for 50′ above and below the abutment. The revetment is as follows:

Revetment for Bank.—Piles 28′ long are driven 3′ apart on the edge of the bank for the required distance up and down stream from the abutment river-wall. Their tops are cut off 7′ above low water. They are connected on the land side by three waling-strips equally spaced from the river-bottom to the top of the piles. Against and

GENERAL PLAN. LOCK AND DAM

PLAN OF

DAM AT KAMPSVILLE LOCK.

Designed by

CAPTAIN W. L. MARSHALL,

Corps of Engineers, U. S. A.

1890

BANK REVETMENT

SECTION

PLAN

EARTH FILLING

Natural Low Water

SECTION AND ELEVATION, DAM AND ABUTMENT

ABUTMENT

GROUND PLAN

LOCKWALL

SECTION AND ELEVATION, DAM AND LOCKWALL

CROSS SECTION

UPPER POOL LOW WATER

NATURAL LOW WATER

EARTH FILLING

Natural River Bottom

SCALES.

SHEET NO. 14

along these, a line of 3″ sheet piling is driven and spiked fast. This revetment is anchored by iron tie-rods to a second line of piles, spaced 6′ apart, driven 17′ further back in the bank. A 10″ × 10″ wale connects the tops of the rear row of piles. The space in rear of the sheet-piling is filled with earth to a height of 16′ above low water, sloping to the top of the sheet-piles with an inclination of 1 on 2. The slope is paved with heavy stones, hand-placed. The foot of the sheet-piling on the river side is protected with riprap.

This dam was finished Sept. 30, 1893. The description of the lock and dam is taken from the published reports and plates.

Detailed Statement of the Cost of Kampsville Dam.

[From Rept. of Chief of Engineers, U. S. A., 1894, p. 2155.]

	Quantity.	Cost per Unit.		Amount.
		Unit.	Cost.	
ABUTMENT.				
Labor				$2,262.16
Material, including stone, piles, etc.				3,237.26
				5,499.42
DAM—LABOR, INCLUDING SUBSISTENCE.				
Dredging				3,144.66
Earth filling, cubic yards	3,332	Cubic yard	$0.17	566.44
Ballasting with rock*, " "	11,795	" "	.404	4,761.30
Framing lumber†, feet, B.M.	313,212	Per M.	13.22	4,140.96
Driving piles, round, number	1,104	Each	1.54	1,704.62
" " sheet, "	2,600	"	.482	1,253.58
Making piles, sheet, feet, B.M.	235,463	Per M.	1.83	432.00
Making piles, sheet, number	2,600	Each	.166	
Transferring coal and ice				81.25
Care and repair of plant				203.74
" of buildings and grounds				105.58
				$16,393.53
DAM—MATERIAL.				
Coal				$1,276.72
Oil, coal, and lubricating				127.64
Piles, round (1,271.28 feet; 120.18 feet), number	1,391			4,128.47
Lumber:				
Oak, feet, B.M.	302,136			9,482.93
Pine, " "	74,891			1,408.14
Oregon fir, " "	171,648			4,377.02
For bakery				53.06
Rubble, cubic yards	11,795			10,615.50
Iron, bolts, etc				1,050.82
Ten dump-cars				810 00
Augers, files, rope, dishes, etc				847.81
				$34,178.11
Total				$56,071.06

* Includes laying track and dumping-platform.

† Includes all transferring lumber from railroa d.

Concrete Construction, Illinois and Mississippi Canal.—The section now under construction is a canal approximately 4½ miles in length, around the lower rapids of Rock River, terminating at the principal mouth of Rock River. The construction works required here are two dams across the arms of Rock River, at the head of the rapids, 4½ miles of canal trunk, 1 guard-lock, 2 lift-locks, 7 sluices, 1 culvert, 2 metal bridges, and 1 ponton farm-bridge. The locks and all masonry, including bridge piers and abutments, sluiceway piers, and the abutments of dams, have been or are to be constructed entirely of concrete of Portland cement and crushed stone and gravel. The hollow quoins of the locks are of cast iron, built into and anchored to the concrete as the work progresses. The concrete is placed with great care, and particular pains are taken to secure masses of concrete without planes or surfaces of weakness, along which cracks and failures might take place. The effort has been made to produce work which should be strong and durable even if the cost of the concrete were increased thereby.

In constructing the masonry the following rules have been adhered to :

"I. The forms or moulds of the walls will be divided by vertical partitions perpendicular to the longest axis of the mass, and the walls will be constructed by filling alternate sections.

"II. The sections will be filled in horizontal layers, well rammed, each layer to be deposited before the 'initial set' of the previously deposited layer. When the work of filling a section is begun, it must proceed without intermission to completion, working night and day if necessary.

"III. The facing and backing must go on simultaneously in same horizontal layers, using the same cement in the facing as in the backing, with no defined lines of demarcation between the facing which contains no stone and the concrete backing.

"IV. When the top surface of the coping is reached it will be finished after ramming by cutting off the excess by a straight-edge, and rubbed smooth and hard with a float. No plastering or wet finishing-coat will be allowed.

"V. The facing of the walls will not be finished by plastering or washing with cement after the forms are removed, nor dressed in any manner beyond chiselling away rough ridges should the plank forming not be smooth.

"VI. The concrete shall be mixed with all the water it will take without water showing after ramming, or without 'quaking' upon ramming.

"VII. At such intervals as may be necessary vertical wells at least 1 foot square will be formed along the middle of the masses of concrete reaching to near the bottom thereof. The masses of concrete after forming will be kept sheltered from the sun, the outer surfaces kept moist and the wells kept filled with water until well set (about three weeks). The wells will then be filled with concrete.

"VIII. In preparing the cement for mixing with other ingredients of concrete from 5 to 10 barrels will be kept thoroughly mixed dry, to guard against chance barrels of defective cement, and the necessary quantity of cement will be taken for each batch from this mixture.

"IX. Two cements of different qualities shall not be used in the same section, but as far as practicable each mass shall be homogeneous throughout, but a slight excess of cement is allowable in the facing to reduce its capacity to absorb water.

"The cements used for the masonry have been three brands of fine-ground German Portlands, but nearly all of it has been made from Alsen's Portland cement (yellow label). Ninety-nine per cent of this cement passes a sieve 2500 meshes to a square inch, 87 per cent passes 10,000 meshes to the square inch; its initial set, determined by one-fourth pound weight on a wire one-twelfth inch in diameter, occurs in from twenty-two to thirty minutes, and it sets hard in about two hours. The rate at which cement was deposited was about 1 cubic yard in five minutes. This rate was not up to the capacity of the mixer, but was determined by the rate at which the ramming into the moulds could be done and the moulds prepared.

"There is no reason, therefore, why the concrete may not be deposited continuously, each layer before the preceding layer has reached its 'initial set.' To accomplish it, however, requires for this particular cement that the sections shall be of such size that each horizontal layer shall not contain more than four batches of concrete, requiring twenty minutes for its deposit; the succeeding batches to be deposited in the same order in each layer.

"In constructing the concrete masonry large stones have not, as a rule, been incorporated in the masses, but the walls have been made as nearly homogeneous in texture as practicable, consistent with the necessary facing along the exposed parts of the masonry. Continuity in depositing and homogeneity in structure are essential elements of success in concrete construction of thin or moderately thick walls, and every effort has been made to attain them.

"On this canal the foundations have been designed with close-fitted sheet-piling at head and tail bays, to prevent under leakage, and the foundation made strong enough to sustain the lock-walls and the chamber full of water; but instead of providing against an accumulation of a possible hydrostatic head of water below the foundation

ILLINOIS AND MISSISSIPPI CANAL. General view of Works at head of Lower Rapids, Rock River.

GUARD LOCK, SLUICE WAYS AND CULVERT

AT HEAD OF

LOWER RAPIDS, ROCK RIVER.

SCALE.

END ELEVATION.

SECTION: M — N.

SECTION: I — J.

SECTION: G — H.

PLAN

SECTION: O — P.

SECTION: E — F.

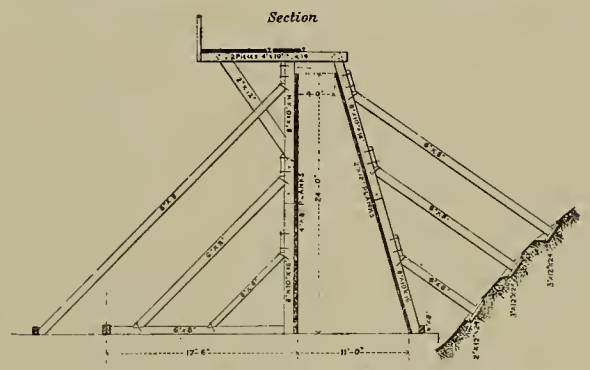
SECTION: C — D.

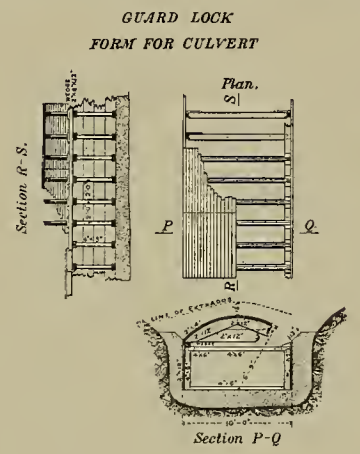
SECTION: A — B

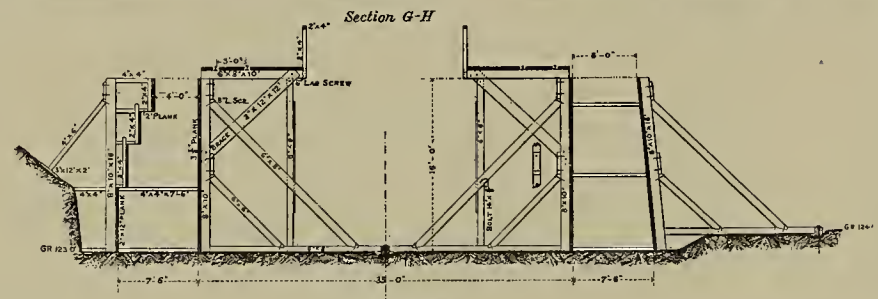
SECTION: K — L.

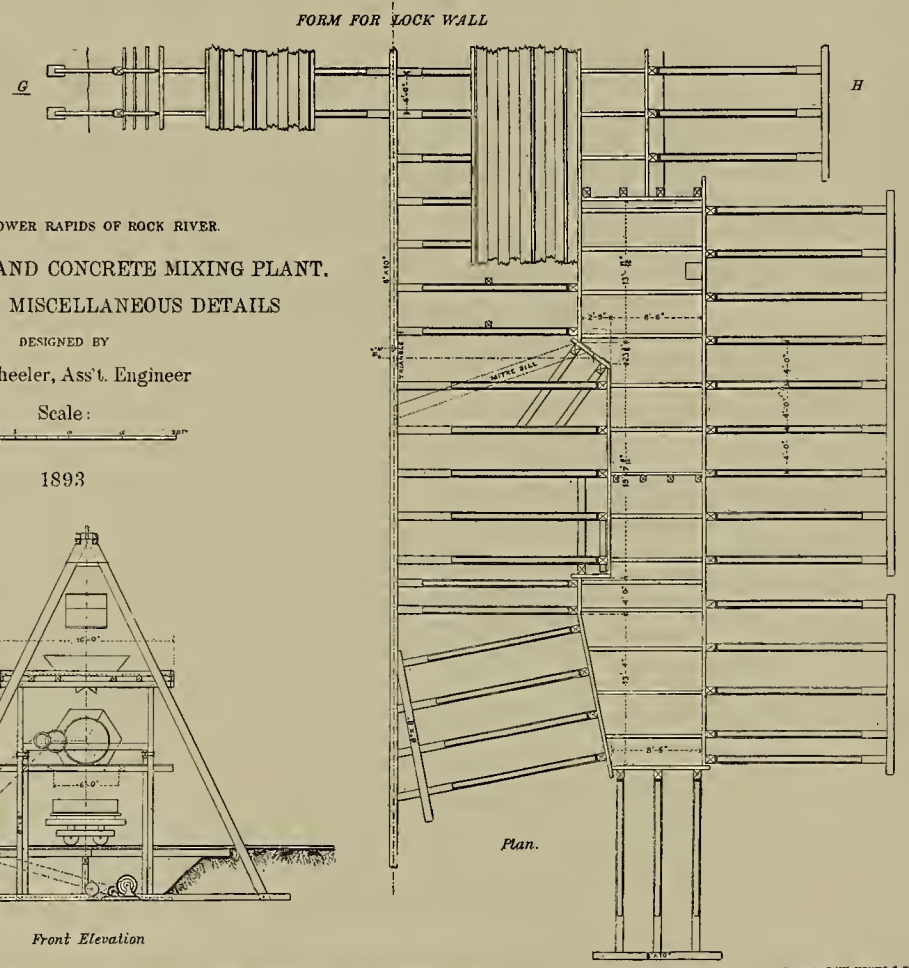
SECTION THROUGH HOLLOW QUOIN.

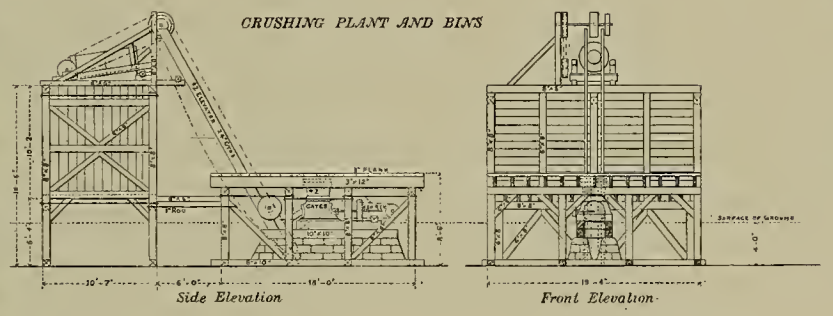
PINTLE AND BASE PLATE











CANAL AT LOWER RAPIDS OF ROCK RIVER.

STONE CRUSHING AND CONCRETE MIXING PLANT.

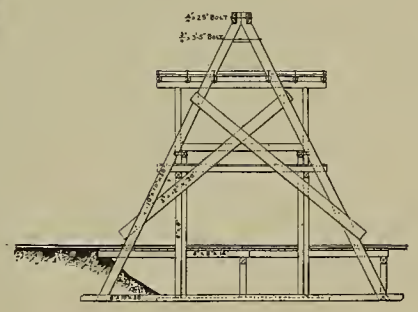
FORMING AND MISCELLANEOUS DETAILS

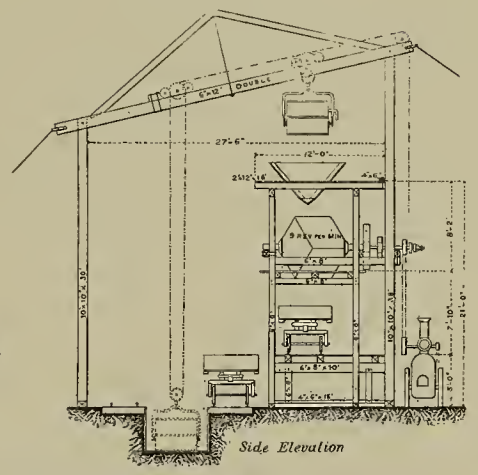
DESIGNED BY

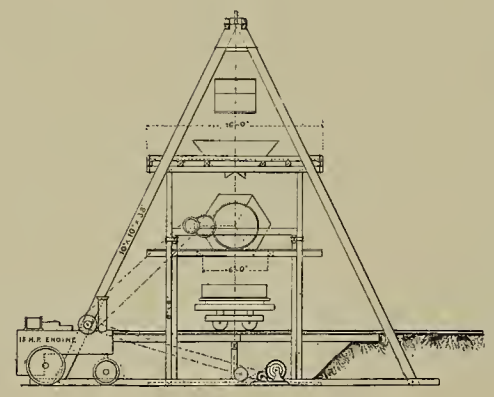
L. L. Wheeler, Ass't. Engineer

Scale:

1893







Drawn by PAUL HEINZE, C. E

The Friedenwald Co., Portfolio, Balto., Md. Eng. 53'3

PLATE XXXI.

ILLINOIS AND MISSISSIPPI CANAL.

Guard Lock, head of Lower Rapids, Rock River. North wall completed ; south wall under construction.

tending to push it up, provision is made for subdraining to the lower level just above the probable position of any coffer-dam, of all accumulations of water under the foundations, or in the rear of the lock-wall, while at the same time prohibiting as far as practicable communication between drains and lock-chambers. Whenever a lock is pumped out the water is also removed from behind the walls and to the level of the foundation."

The works at the head of the lower rapids, Rock River, shown in Plate XXVIII and in plan and section on Plate XXIX, consist of a guard-lock; a sluiceway closed at the head by three Taintor gates; an earthen abutment with concrete retaining-walls; and a drainage culvert (built to carry a small stream across the line of the canal), extending from the land side of the land-wall of the lock, beneath the canal and sluiceway, to a pump-chamber and outlet in the abutment, below the south dam across Rock River. The dams across the river are not shown.

The dimensions of the lock and of the other masonry are seen on the plate. The Taintor gates are each 21′ wide and 13′ high. The up-stream face of each is a portion of the surface of a right cylinder the radius of the base of which is 12′ 3″, with the centre 6″ above the horizontal trunnions about which the gate is revolved. The gates are raised by means of a hoisting-carriage, which runs on a track on a bridge over the gates.

Plant—Cost of Concrete and Gates.—The concrete plant is shown in Plate XXX. The stone-crusher is a No. 2 Gates, with elevator and screen. The mixer is a 4′ cubical box, actuated, as is also the hoist, by a 15-H.P. portable engine. The mixer is turned at the rate of nine revolutions per minute. The entire frame of the mixer and hoist is assembled with bolts so as to be removable readily. A cement-box was used in which 5 to 10 bbls. of cement were emptied and the contents thoroughly mixed. From this box the charge for the mixer was taken. The water was measured from a small barrel, and the quantity used for a charge varied from time to time with the weather and the condition of the ingredients. The sand, pebbles, and broken stone were loaded into side dump-cars of the required dimensions, and with the dry cement and water were dumped into a charging-box which held about 45 cu. ft., and which was sunk flush with the surface of the ground. This box was then hoisted and carried by a traveller over a large hopper and dumped into the mixer. The truss over the mixer was set at such an inclination that the same cable hoisted the box and carried it along the truss without the aid of auxiliary apparatus. After mixing, the charge was dumped into side dump-cars and drawn by a horse to the forms. The materials for the facing and coping were mixed entirely by hand, with the same precautions.

The concrete forms are shown on Plates XXX and XXXI. The forming consisted essentially of a longitudinal sill in the middle of the lock, bolted to the foundation, or anchored to the rock; transverse sills, notched to receive braces; 8″ × 10″ posts; and a face lining of 4″ × 8″ pine dressed to a uniform thickness. When the posts were lined and plumbed, the braces were set in the notches and abutted against 4″ × 8″ blocks, lag-bolted to the posts, and the lining was then placed. The back was lined with rough 2″ plank, braced against the earth slopes. A platform, supported by the face-posts and auxiliary bracing, was built along the face, at the level of the top of the form, to carry the tracks for the dump-cars. Vertical bulk-heads divided the forming into sections. Each section was filled with freshly mixed concrete placed in thin layers, without stopping work until the coping was finished. The largest sections contained about 250 cu. yds. The time required to fill the sections varied from 8 to 24 hours.

"The proportions used were 1 cement, 2½ sand, and 5 broken stone. When pebbles were used they replaced one of the parts of stone. All of the exposed surfaces of masonry was composed of 1 part cement and 2 parts sand. The facing was made 8 inches thick of this material and the coping 5 inches. A small amount of Utica cement was used as filling back of culvert-walls and as foundation for retaining-walls. The total amount of concrete deposited at the guard-

lock is 3762 cu. yds., costing $32,122.24, or at a cost of $8.54 per cubic yard. One cubic yard of concrete required 1.40 barrels of cement.

Statement of Cost of 3762 Cubic Yards of Concrete Masonry at Guard-lock.

" 5246 barrels Portland cement	$15,603.82
152 barrels Utica cement	83.60
2901 cubic yards crushed stone	1,709.15
1970 cubic yards sand	1,398.41
128 cubic yards screened pebbles	113.30
Lumber for forming	2,635.96
Miscellaneous bills	416.72
Labor, building forms, trestles, etc	2,726.72
Labor, mixing and placing concrete	6,693.02
Labor, pumping, etc	741.54
Total	$32,122.24 "

The lock-gates were similar to those of the Kampsville Lock. The cost of the lock-gates and of the Taintor Gates was as follows:

	Lock-gates.	Sluice-gates.
" Lumber	$511.64	$408.60
Ironwork	807.57	732.45
Paints and miscellaneous bills	70.18	105.00
Labor, carpenters, hauling, etc	923.52	774.94
Painting	30.35	45.53
Labor, pumping, and miscellaneous	265.12	265.12
Total	$2,608.38	$2,331.64

" Crib approaches have been built both above and below the lock. Below the lock the cribs are continuous, 8′ wide, 9′ high, and have a combined length of 228′. Above the lock the crib on south side is also continuous, being 8′ wide, 13′ high, and 110′ long. On the north side the cribs are detached, and consist of three cribs, 16′ × 16′, and one crib 16′ × 26′, all 11′ high.

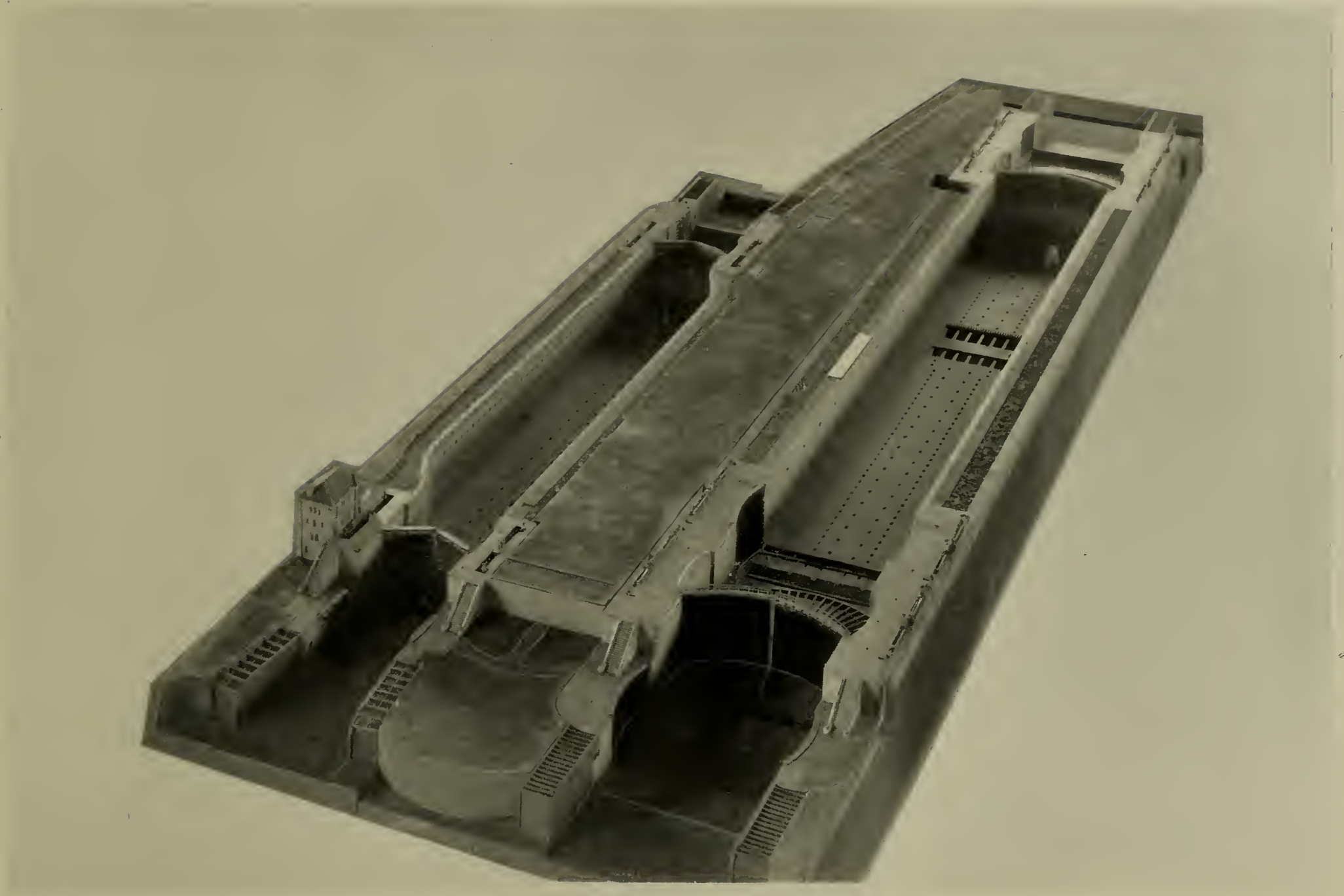
" The cost of the cribwork is as follows:

" Lumber	$780.72
Iron, drift-bolts, etc	36.26
Labor, carpenters, etc	366.04
Labor, filling with stone	592.50
Total	$1,775.52 "

The above descriptions were taken mainly from Appendix KK, 6, of the Report of the Chief of Engineers for 1894.

St. Mary's Falls Canal Locks.—The lock now in use is 717′ long from out to out, 515′ long between gates, 80′ wide in the chamber, and 60′ wide at the gates. Its lift is 18′, and the mean depth on the upper mitre-sill is 16′. It was completed in 1881. The lock is operated entirely by hydraulic engines, actuated by two turbine-wheels. It is the smaller of the two locks shown in Plate XXXII. This plate is taken from a photograph of the model of the present lock and the new 800′ lock. The locks are shown from their down-stream ends. A portion of the floor of the new lock is removed, to show the arrangement of the culverts.

800-foot Lock, St. Mary's Falls Canal.—This is now under construction by contract. It will be 1124′ long from out to out of the masonry, 800′ long between the quoins of its main gates, and 100′ wide throughout. The depth on the mitre-sills is to be 21′ at ordinary low stages, and the lift 18′. There will be upper- and lower-guard gates near the extremities of the lock, and auxiliary lower gates 96′ above the main lower gates. The entire site was excavated to the solid rock, and the foundations for the walls and the floors were built up to the required height with concrete. The floors of the head and tail bays and of the lock and gate chambers are sheathed with plank. The gates will be of arch form, and will be built mainly of low steel. The lock will be filled from a pit in the floor of the upper gate-chamber, rectangular in cross-section, 16′ wide and 12′ deep, reaching across the chamber immediately in front of the extrados of the arch wall of the upper mitre-sill, and concentric with it. From this pit six culverts pass through the arch and unite into four, which extend the length of the chamber, beneath the floor, to a similar pit straight across the lock just above the auxiliary lower gates. The water enters the chamber from the culverts through 214 openings in the floor. The filling valves are vertical, and rest against the extrados of the upper sill arch, covering the culvert openings. The emptying valves are similarly placed against the down-stream face of the lower



MODEL OF THE 1881 LOCK AND OF THE NEW 800-FOOT LOCK, ST. MARY'S FALLS CANAL.
Portion of floor of new lock removed to show filling and emptying culverts.

QUOIN POST.
VERT SECTION ON 'B'

VERTICAL SECTION ON A, LOOKING UP-STREAM
& DEVELOPMENT OF INSIDE SURFACE OF SHEATHING

MITER POST.
VERT. SECTION ON 'H.'

PLAN OF GATE

PLAN OF ARCH Nº 8, AND SECTION OF WATER-CHAMBER ON 'F-F'

SOUTH LEAF OF LOWER LOCK GATE, ST. MARY'S FALLS CANAL.

pit. To empty the lock the water passes from this pit through culverts to a similar pit just above the lower guard-gate, which is open to the lower level.

A guard-crib of timber, 64′ long, 20′ wide, and 28′ high, filled with stone, will be placed at each end of each wall.

The walls are to be 43½′ high above the level of the chamber floor. The coffer-dam is 1500′ long and 300′ wide. It is made of tight cribs of square timber filled with puddle clay. The masonry is coursed ashlar of the following character:

The cut stone is to be uniform in appearance, free from all defects which would impair its strength or durability, at least as good as that in the lock of 1881, and must weigh at least 148 lbs. to the cu. ft. Patterns of zinc for the cut stone are furnished to the contractor. Stones for the mitre-walls have ⅜″ joints throughout. All other cut stones have ⅜″ joints excepting where they overlie backing, where the joints may be 1″, and excepting vertical joints beyond 18″ from the wall face. The stones must be accurately laid, with full bearings, and with top surfaces horizontal for each course. All edges on show lines must be perfect. Show faces must be cut true and even, without depressions of any kind. Within the draught-lines, stones of courses below the upper twelve courses of the main walls may be rough-finished, with no depression below the plane of the face, and no projection greater than 1″ beyond the plane of the face. The face stones of the gate recesses must be finished throughout. The backing stones must be of an approved quality. The smallest must have an area of bed of at least 5 sq. ft., except in particular cases. They must have approximately parallel beds, square corners, and a thickness of at least 8″.

Mortar and Concrete.—The specifications for the cement are of the usual character for high-class natural and Portland cements. The cement is bought under a separate clause in the masonry contract, and after passing the tests is cared for by the United States and issued to the contractor as required. The kind of cement to be used in each part of the work is designated by the engineer. The mortar used for laying the cut stone is (by measure) 1 Portland cement and 1 sand; that for backing is 1 Milwaukee natural cement and 1 sand.

The concrete for the foundations contains 1 natural cement, 1½ sand, and 4 stone; that for the filling, 1 cement, 2 sand, and 4 stone.

The sand is pumped by a dredge from the lake bottom. The stone was crushed so as to pass through a two-inch ring, screened and washed. The stone thus prepared, piled loose, contained 46.5 per cent of voids. It was found from tests carefully made that 5.48 cu. ft. of natural cement, 8.22 cu. ft. of sand, and 2.93 cu. ft. of water, when mixed, made about 9.8 cu. ft. of mortar, and this mixed with 21.9 cu. ft. of broken stone, made about 23.5 cu. ft. of rammed concrete, showing the voids then filled with mortar to be 38 per cent, and an excess of 1.5 cu. ft. of mortar, or 15 per cent more than was necessary to fill the voids.

The concrete was mixed by hand and placed in layers about 8″ thick for ramming. The concrete was laid to a line 3′ outside the face of the masonry. The average thickness of the concrete foundations is 3′.

Stone.—The work now being carried on is under the largest single contract—that for the masonry. The backing stone is quarried on Drummond Island, Mich. It is a compact, bluish gray, crystalline limestone, having a conchoidal fracture, and weighs about 170 lbs. to the cubic foot. The face stone is from Kelly Island, Ohio. It is a limestone weighing 157.36 lbs. to the cubic foot. Tested in 3″ cubes, faced with plaster of Paris, it had an ultimate crushing strength of 12,177 lbs. to the square inch. The stone is brought in the rough from the quarry, and is cut in a stone-yard located on the lock grounds. In 1893 the following plant was used by the contractor at the lock and the Drummond Island quarry:

Plant, Drummond Island Quarry.—Pile wharf, 250′ × 75′; quarry face, 700′ long × 30′ high; on wharf, two steam-derricks of the make and size of those to be described at the lock; at the quarry, 9 horse-power derricks; a double track, with the necessary sidings, crossings, switches, and spurs, extending from the wharf the entire length of the

quarry ; 12 ten-ton platform-cars, and 30 dump-cars ; 5 barges for transporting stone from quarry to lock.

Stone-yard.—1100′ long × 150′ wide, situated just in rear of the Fort Brady pier. A track 1000′ long, of 5″ rail and 16′ gauge, runs parallel to the pier and 70′ from its face. Near each end, 18′ from the face of the pier, is a stiff-leg derrick of 15 tons capacity, with boom 50′ long. The booms can make a complete revolution, and are raised and lowered by steam. On the track is a McMyler travelling-crane, with a maximum travelling speed of 600′ per minute. Its reach is 50′ from the middle of the track, at which point it is able to lift 4 tons. Its capacity is said to be 10 tons, lifted 30′ from the middle of the track.

In the centre of the yard, back of the track, are four steam-planers, run by a 100-h.p. automatic-cut-off engine, under shelter. In the same building are also the engine and boiler rooms, blacksmith-shop, and grinding-room. The planing-room is open on the side of the track, but is provided with heavy canvas curtains for use in severe weather. There is also a pattern-room and tool-house in the yard. All are lighted with electricity for night-work.

The finished stones are transported on scows from the yard to the lock. The average force of employees in the yard, including the force for loading and unloading the stone, was: 1 foreman, 71 stone-cutters, 8 planer runners, and 34 other laborers.

Sand.—The sand-scow is 100′ × 34′, and is provided with a No. 6 sand-pump and rotary engine. A small derrick operated by a small rotary engine is used for unloading the sand. One tug is employed for the sand-scow and for the three scows which carry the stone from the yard to the lock.

Rock-crushing.—The plant for this purpose comprises two Gage rock-crushers, one No. 2 and one No. 4, operated by two horizontal engines and boilers. They are placed on the north side of the lock-pit.

Pumping Plant.—One 10″ and one 5″ centrifugal pump, and one 10″ and one 8″ piston-pump, run to about $\frac{1}{4}$ of their capacity, keep the lock-pit perfectly dry at all times.

The water for the work is furnished from a storage-tank of 4000 gallons capacity, filled by a No. 1 Worthington pump from the canal, through service-pipes laid on either side of the lock-pit, and tapped at suitable intervals for attaching hose. About 7725′ of tramway, 3′ gauge, has been laid in and around the lock-pit, with two inclines leading into the pit. A Lidgerwood double-drum, double-cylinder, hoisting-engine is placed at the head of each incline. Forty ten-ton platform cars are used.

Derricks and Cranes.—Stone is unloaded from the scows and placed on the cars by 4 steam-derricks. Each derrick is operated by an $8\frac{1}{2}'' \times 10''$ double-drum, double-cylinder Lidgerwood engine. Each has a boom 50′ long and mast 68′ high, and two stiff legs, each 66′ long, supported by A frames 34′ long.

An 85-lb. rail, 16′ gauge, tramway, supported on trestles, runs the length of the lock, inside the line of the walls, on each side. On these tramways are eight McMyler travelling-cranes, with 54′ booms, for placing the stone in the lock-walls. Four of these are of the capacity of the crane in the stone-yard. These are operated by 12″ × 14″ double-drum, double-cylinder engines. The remainder have a capacity of 5 tons, placed 30′ from the centre of the track, and their engines are 9″ × 12″. Four stiff-leg derricks, each with 35′ mast and 50′ boom, to be operated by horse-power, are placed on each side of the lock at one end to assist in laying the backing masonry in the wide part of the wall.

Labor—Year's Work.—The average force at work in the lock-pit comprised 27 masons and 89 other laborers, 2 double teams and 5 single teams. The maximum force for a single month was 28 masons, 138 other laborers, 2 double teams, and 9 single teams. The work done by the contractors during the fiscal year ending June 30, 1893, was as follows: Stone planed, 5536 pieces ; cut stone ready for laying, 7354 pieces ; concrete laid, 964 cu. yds., containing an average of 1.55 bbls. of cement to the cubic yard ; cut stone lai.. 5943 pieces, containing 8065 cu. yds., with an average of 0.235 bbl. of cement in the mortar per cu. yd. of masonry ; backing laid, 26,271 cu. yds.,

with an average of 1.179 bbls. of cement in the mortar per cu. yd. of backing; earth filling placed behind walls, 11,172 cu. yds. Laying was suspended between October 29, 1892, and April 21, 1893.

Cost.—The prices for this work under the contract of February 9, 1891, are: Portland cement delivered at lock, $3 per bbl.; natural cement delivered at lock, $1.30 per bbl.; cut dimension-stone, Ohio limestone, delivered at lock, $26 per cu. yd.; laying cut stone in lock-wall, $2.50 per cu. yd.; backing stone, Drummond Island limestone, delivered at lock, $6 per cu. yd.; laying backing-stone in lock-wall, $2.50 per cu. yd.; laying concrete in foundations, etc., $4.50 per cu. yd.; filling earth behind wall, $0.50 per cu. yd. These prices cover all costs of labor, appliances, and materials (sand, etc.), and all expenses of whatever nature, except for United States superintendence, that may arise during the progress of the work. The contractor is held responsible for the proper care of completed portions of the work during the continuance of his contract.

CONSTRUCTION WORK, QUARTERMASTER'S DEPARTMENT, U. S. ARMY.

Scope of Annual Work.—The work of the Quartermaster's Department of the Army includes an immense business in the purchase and issue of supplies, and the arrangements for the transportation of troops and supplies, which does not fall within the province of this book. The scope of the construction work of the Department can be seen from the following list, which gives the number of contracts for such work entered into by the Department during the fiscal year, 1892–1893, viz.: For buildings, 78; for lumber for miscellaneous purposes, 1; for sewerage, 5; for water and water-supply, 27; for wells, 3; for heating apparatus, 14; for building material, 3; for plumbing, 19; for repairs to buildings, 7; for gas-piping, 2; for repair of wharf, 1; for roads and sidewalks, 10; for cooking apparatus, 4; for grading, 1; for stoves and ranges, 4; for wire fencing, 1; for earth filling, 1; for steel bridge, 1; for sea-wall, 1; for stone flooring, 1. In the list for the preceding year, in addition to these items, there appears the construction of cisterns, of walks and stairways, of rifle-range, contract for hauling earth, gravel, etc.; for iron gateway, for crushed granite, for oyster-shells, for iron and jail work, etc.

The bulk of the appropriations for construction work is expended under contracts. Only minor repairs and minor construction work are done by hired labor. In the fiscal year 1893 the amount actually expended for construction and repair of buildings was $570,800; for wharves, roads, walks, grading, bridges, water-supply, sewerage, etc., $147,900. The appropriation for the fiscal year 1894–1895, for the construction and repair of barracks, quarters, etc., is $650,000; for the construction and enlargement of such posts as the Secretary of War may select, $200,000; and for roads, wharves, water-supply, sewerage, etc., a portion of the $2,500,000 appropriated for these purposes and for transportation.

The work done under these appropriations is of a character too well known to require detailed description. As new buildings are authorized from time to time, advertisements are placed in the leading trade papers and in some of the papers published in the vicinity of the post where the buildings are desired, calling for proposals, and giving the address of the officer who will furnish copies of the specifications and blank forms to all who desire to bid for the work. The buildings called for from time to time include single and double sets of officers' quarters, single and double sets of non-commissioned officers' quarters, barracks, hospitals, mess-halls, guard-houses, stables, store-houses, etc.

Quarters.—These are dwelling-houses of stone, brick, or frame, the specifications for which are similar to those usually prepared by architects for similar buildings. There are three general grades: those for commanding and field officers, those for company officers, and those for the non-commissioned staff. The first two grades differ only in the size and number of rooms. In general character these houses are quite similar to suburban houses of the better class. The houses of the first class are usually detached double houses. Those of the second class are frequently two under one roof. They are

then known as "double sets." The houses of the third grade are like those of artisans. Single sets of brick or stone quarters at the new posts cost $7000 to $12,000, double sets from $6500 to $15,000. Single sets of brick non-commissioned officers' quarters cost about $2000; double sets, $3500 to $4000.

Barracks.—The barracks lately built at Willets Point, N. Y., may be considered as fairly typical in construction, for large companies. They are of brick, with slate roofs and stone foundations. Each barrack consists of a centre and two wings. The centre is three stories high, 54′ front, and 46′ deep. Each wing is two stories high, 76′ long, and 29½′ deep. The stories are 12′ high in the clear. The ground floor contains two dormitories in the wings, each 26′ × 74′, and in the centre, two halls at right angles, a reading-room 18′ × 20′, a lavatory 18′ × 20′ (containing 11 fixed basins, and 4 bath-tubs in alcoves, all with hot and cold water), a company office, first-sergeant's room, and two non-commissioned officers' rooms, each 10′ × 18′. The second floor contains the same rooms as the first, with the addition of one room over the front hall. The third floor, main building, contains a gymnasium 30′ × 44′ 8″, and a work-room 20′ × 44′ 8″. In the basement under the wings are storerooms; under the main building are two storerooms, a fire-room (containing two boilers for steam-heating, and one boiler for the hot water for bathing), and a retiring-room fitted with ten water-closets and seven urinals. Verandas, with their fronts flush with the face and back of the main building, are on each side of each wing, along both stories.

The foundation-walls are of stone laid up in cement mortar, pointed and plastered on the outside, with outside blind-drain of dry stone. The basement is floored with concrete. The other floors are double, with tops of yellow pine. The interior finish is also yellow pine. The outside walls are from 2½ to 1½ bricks thick. The interior is lathed and plastered. The cost of the barrack, finished in the summer of 1894, was: for construction, $22,716; for plumbing, $2231; for steam-heating, $2425.

The "Centre Barrack" at San Antonio, Texas, is of brick, trimmed with stone, with tin roof. It consists of a centre, 38′ front, 61′ 8″ deep, and three stories high; and two wings, each 32′ × 32′, and two stories high. The first floor, beginning at one end, contains a kitchen 16′ × 18′, with a cook's room 10′ × 10′ and pantry 10′ × 6′ opening from it; a mess-room 24′ × 28′; a hall; two rooms 13′ × 9′, a lavatory 26′ × 14′, and three other rooms—two 15′ × 14′, and one 25′ × 14′. On the second floor are two dormitories, each 40′ × 29′, and a ⊤-shaped hall, with winding-stair towers at its front corners. This building cost $12,000.

Adjoining this building and continuous with it are other barrack buildings, of brick, with tin roofs, each 121′ 3″ long and 31′ 4″ deep, of two stories, with verandas 10′ wide on both stories along the entire front. The first floor contains on one side of a central hall, a kitchen, cook's room, pantry, and mess-hall; and on the other side of the hall, a day-room, lavatory, tailor-shop, first-sergeant's room, storeroom, and a sergeants' mess-room. The second floor contains four dormitories, two on each side of a central hall, 8′ wide. The cost of each barrack building was $9800.

The double barrack at Fort Ethan Allen, Vt., cost $37,000. Other barrack buildings recently erected cost from $20,000 to $40,000.

Hospitals.—A post hospital for twenty-four beds is of the following design: The building is frame, with slate roof, on stone foundations. There is a central part, two stories high, 38′ 4″ front × 38′ 4″ deep; two one-story wings, each 46′ × 26′; and a rear wing, with a second story over the front half. A veranda 10′ wide runs along the front and ends of the building. Each side wing contains one ward, 24′ × 45′. The ground floor of the central portion contains two halls at right angles, and four rooms each 15′ × 15′. The ground floor of the rear wing contains a dining-room, pantry, and kitchen. On the second floor of the main building are four rooms, and in the rear wing one. Such a hospital at Willets Point, N. Y., cost $13,200.

Mess-halls.—For combined messes, these contain one large dining-room, one kitchen, bakery, storerooms, pantry, and sleeping-

rooms for the attendants. In some cases they contain offices as well.

The brick mess-hall and administration building at Plattsburg barracks, N. Y., cost: for construction, $38,000; for plumbing, $1900; for cooking apparatus, $3000. The brick mess-hall at Fort M'Pherson, Ga., cost: for construction, $24000; for plumbing, $1057; gas-piping, $180; steam-heating, $4090; for cooking apparatus, $3585.

Guard-houses.—The new brick guard-house at Willets Point is one story high, with hipped slate roof, on stone foundations, with cellar under the front half and veranda across the front. It is 46′ 10″ front, and 49′ deep. The front half contains an office 12′ 4″ × 10′, a non-commissioned officers' room 12′ 4″ × 10′, a guard-room 25′ × 25′, an officer of the guard's room 8′ 6″ × 7′ 2″, a gun and coat room 8′ 6″ × 6′, and a toilet-room 8′ 6″ × 11′ 6″. In the rear half is the prison room, 44′ 10″ × 21′. This contains an iron cage 37′ 6″ × 13′ 7″, divided into three cells (at one end) and two compartments. A corridor surrounds the entire cage. The building is heated by steam, the boiler being located in the cellar. The cost of this building was $7650.

The brick guard-house at Fort M'Pherson cost $14,860; that at Fort Ethan Allen, Vt., $7000.

CHAPTER IV.

TREASURY DEPARTMENT PUBLIC WORKS.

UNITED STATES LIGHT-HOUSE ESTABLISHMENT—LAWS AND REGULATIONS.

Organization and Duties of Light-House Board.—By the Act of August 7, 1789, the United States accepted the cession of the titles to the existing light-houses on the coast and agreed to maintain them thereafter. They were placed under the charge of the Secretary of the Treasury, where they since have remained, excepting for the period from 1792 to 1802. In 1852 the Light-House Board was created by Act of Congress and attached to the Treasury Department. The Secretary of the Treasury is *ex-officio* President of this Board. (Sec. 4654, R. S.)

The Light-House Board is composed of two officers of the Navy of high rank, two officers of the Corps of Engineers of the Army, and two civilians of high scientific attainments, with an officer of the Navy and an officer of Engineers of the Army as secretaries,—all appointed by the President. (Sec. 4653, R. S.) A chairman, selected by the Board, and the two secretaries are its executive officers.

Under the superintendence of the Secretary of the Treasury the Light-House Board has charge of the construction, illumination, inspection, superintendence, and maintenance of light-houses, beacons, and other aids to navigation, and has the charge and custody of all archives, papers, etc., appertaining to the Light-House Establishment. (Sec. 4658, R. S.) Subject to the approval of the Secretary of the Treasury, it is authorized to prescribe regulations for a proper administration of the Light-House Establishment. (Sec. 4669, R. S.)

Under the direction of the Light-House Board, the engineer secretary, or other engineer officer detailed for the purpose, prepares all plans, specifications, and estimates for the construction and repair of towers, buildings, etc., connected with the Light-House Establishment. All contracts are to be entered into by authority of the Board and through its regularly authorized officers. (Sec. 4665, R. S.)

Light-House Districts.—For purposes of administration, the sea and lake coasts of the United States and such of the inland waters as are supplied with aids to navigation, are divided into sixteen districts. (Sec. 4670, R. S., amended by Act of July 26, 1886.) The limits of these districts are given elsewhere. (See p. 236.) An officer of the Army or Navy is detailed to act as inspector for each district, subject to the orders of the Light-House Board. (Sec. 4671, R. S.) The Secretary of the Treasury is further authorized to assign to any collector of customs the superintendence of any designated light-house, etc. (Sec. 4672, R. S.) The duties of the inspector are, in general, to attend to the personnel of the district, to supplying the lights, and to maintaining the floating aids to navigation. Engineer officers of the Army are detailed as light-house engineers for the several districts. (Sec. 4664, R. S.) The light-house engineer is charged with all matters pertaining to the construction and renovation of the fixed aids to navigation in his district. The inspectors and engineers act as disbursing officers of the funds required in the performance of their respective duties.

Appropriations for Light-House Establishment.—New light-houses are established by Congressional enactment. Memorials requesting new aids to navigation are sent direct to the Light-House Board, or are referred to it by Congress. In each case the Light-House Board after full consideration makes its recommendations to Congress, which in its discretion authorizes the establishment of lights and makes the necessary appropriations for their construction. The Light-House

Board also submits to Congress annual estimates of the funds required for maintaining the Light-House Establishment during the ensuing year. The appropriations for the expenses of the Light-House Board are usually made in the "Legislative, Executive, and Judicial Appropriation Bill," and are fiscal-year appropriations. The appropriations for the maintenance of the Light-House Establishment and for the construction of new lights are usually in the Sundry Civil Bill. The appropriations for maintenance and repairs are general in their nature; for new lights, special. The appropriations for construction and repairs continue available until expended; the remainder are fiscal-year appropriations. After the light-house has been completed and all outstanding liabilities paid, any balance remaining from the appropriation for its construction must be returned to the Treasury. (Act June 23, 1874.)

All appropriations for public buildings under the control of the Treasury Department are available immediately upon the approval of the act containing such appropriations. (Sec. 3684, R. S.)

BUSINESS METHODS.

The general provisions of the Revised Statutes and the general regulations of the Treasury Department apply to disbursement of funds in this Department, as in all others under the Government.

Chapter I gives the laws and regulations relating to disbursements on page 1; to labor, page 1; for protection of persons furnishing material or labor for use on public works, page 1; to purchase of land, page 2; to legal holidays, page 2; to purchases and contracts, page 2; to payments, page 5; to method of obtaining duplicate of lost check, page 7; to form of checks, page 8; to payments to corporations, page 9.

Allotments and Authorities.—As previously stated, the district officers, engineer and inspector, make the disbursements necessary for the construction, maintenance, and care of the aids to navigation of their respective districts. These disbursements are made under specific authorities granted by the Light-House Board. Each district officer makes an annual statement of the work which in his judgment is needed in his division of the district duties during the coming year, with a detailed estimate of the cost of materials, labor, etc., on proper forms, furnished by the Board. With these annual statements as a basis, the Board makes the allotments for the year from the appropriations available, and gives notice of them to the district officers. It also assigns to the proper district officers any new work which may have been provided for by Congress.

The notification to the district officers of the allotments made authorizes expenditures for certain purposes only, such as payments of salaries of authorized employees; payments of authorized expenses of offices, tenders, and depots; the purchase of materials for repairs, etc., under the annual contracts for miscellaneous supplies; the purchase of fresh provisions, groceries, water, and medicines for vessels and stations; fuel for vessels when absent from their stations; and for emergency purchases to limited amount for a single object.

For all other expenditures specific authority must be obtained. For such expenditures the necessity for a proposed work must be explained; detailed estimates of labor and materials must be submitted; and also the method by which it is proposed that the work shall be done—whether by contract, by hired labor, or otherwise. If by contract, the proposed method of advertising must be stated; if by hired labor, etc., the reasons therefor must be stated. It also must be stated whether the proposed expenditure is to be made with funds on hand or allotted, and from what appropriation.

The proposed work having been authorized by the Board, if it is to be done by contract, copies of the advertisement, specifications, and proposals for the work must be submitted for approval; if by hired labor and the purchase of materials in open market, request for authority to purchase the materials only (unless the dealer is to furnish both labor and materials, in which case the entire cost is stated) must be submitted, accompanied, if practicable, by an abstract of offers previously obtained, by a copy of the circular letter inviting offers, and by the original offers received in response thereto. Should

it be impracticable to obtain and forward offers, the reasons which prevent must be fully and explicitly stated. When prompt action is required, all of the papers called for may be forwarded at the same time, instead of first obtaining general and then specific authority.

Estimates of expenditures and requisitions for funds, which must not be for an amount greater than is required to meet the current demands, are submitted quarterly. These funds are drawn from the Treasury in the usual manner, and are deposited at a sub-treasury or United States depository, to the credit of the disbursing officer and subject to his official check.

Purchases and Contracts.—In addition to the provisions of Sec. 3709–10, etc., R. S., the following special laws govern purchases under the Light-House Establishment:

"No member of the Light-House Board, inspector, light-keeper, or other person in any manner connected with the light-house service, shall be interested, either directly or indirectly, in any contract for labor, materials, or supplies for the light-house service. . . ." (Sec. 4680, R. S.)

Purchase of Land and Materials.—"The Light-House Board is authorized, whenever an appropriation has been or may be made by Congress for a new light-house, the proper site for which does not belong to the United States, to purchase the necessary land, provided the purchase-money be paid from the amount appropriated for such light-house." (Sec. 4660, R. S.) (See also Act appd. Aug. 1, 1888, p. 2.)

The erection of any fixed aid to navigation is forbidden until jurisdiction over the site has been ceded to the United States. (Sec. 4661, R. S.)

"A cession by a State of jurisdiction over a place selected for the site of a light-house, or other structure or work of the Light-House Establishment, shall be deemed sufficient within the preceding section, (Sec. 4661, R. S.), notwithstanding it contains a reservation that process issued under authority of such State may continue to be served within such place. And notwithstanding any such cession of jurisdiction contains no such reservation, all process may be served and executed within the place ceded, in the same manner as if no cession had been made." (Sec. 4662, R. S.)

The Light-House Board is authorized "to lease the necessary ground for all such lights and beacons (on the inland waters named in the act, which includes all which are provided with aids to navigation by the Light-House Establishment) as are for temporary use or are used to point out changeable channels, and which in consequence cannot be made permanent." (Act appd. March 3, 1893.)

"The Secretary of the Treasury is hereby authorized, whenever he shall deem it advisable, to acquire, by donation or purchase, in behalf of the United States, the right to use and occupy sites for life-saving or life-boat stations, houses of refuge, and sites for pier-head beacons, the establishment of which has been, or shall hereafter be, authorized by Congress." (Act appd. March 3, 1875.) (See also Act appd. August 1, 1888, p. 2.)

"All materials for the construction and repair of light-houses, light-vessels, beacons, buoys, etc., shall be procured by public contracts, under such regulations as the Board may from time to time adopt, subject to the approval of the Secretary of the Treasury; and all works of construction, renovation, and repair are to be made by the orders of the Board, under the immediate superintendence of their engineer secretary, or of such engineer of the Army as may be detailed for that service." (Sec. 4666, R. S.)

"No contract for the erection of any light-house shall be made except after public advertisement for proposals in such form and manner as to secure general notice thereof, and the same shall only be made with the lowest bidder therefor, upon security deemed sufficient in the judgment of the Secretary of the Treasury." (Sec. 4667, R. S.)

EXTRACTS FROM REGULATIONS, LIGHT-HOUSE ESTABLISHMENT.

Manner of Procuring Materials and Labor.—"All work for the Light-House Establishment shall be made under approved contracts.

upon bids called for by public advertisement, by tenders, or by day's labor, as may be previously determined. Where works are constructed by day's labor, the materials for them shall be provided, as far as practicable, by contract, after public advertisement." (L. H. R. 135.)

"The Board therefore directs light-house inspectors and light-house engineers to advertise in newspapers for bids, and to take the proper measures for making contract in all cases, except those of great urgency. . . . ." (Extract from circular letter Office of Lighthouse Board, Oct. 19, 1894.)

Advertisements.—"All advertisements for proposals for supplies, materials, rations, fuel, or other articles, or for service by contract, shall be dated, and shall state explicitly the hour of the day and the day of the week and month the bids will be publicly opened." (L. H. R. 131.)

"Advertisements . . . shall be published in such newspapers only as may be designated by the Board." (L. H. R. 132.)

Proposals.—Proposals for supplying materials or labor under contract must be made on a printed form furnished by the advertising office.

The following are the official instructions to bidders:

"INSTRUCTIONS TO BIDDERS.

"*N. B.—Failure to comply with these instructions renders the bid informal and liable to be rejected.*

"1. All bids must be made upon the printed form annexed hereto.

"2. Each bid must state the sum for which the
as shown on the drawings and described in the specifications, will be
.

"3. The bidder's place of residence, with county and State, should be given after his signature, which must be written in full.

"4. Any one signing a bid as the agent of another, or of others, should file with it legal evidence of authority to do so.

"5. When firms bid, the name of the firm and the full name of each member thereof should be written at the beginning of the bid; for instance, 'Smith, Brown & Co., of the city of New York, a firm composed of John S. Smith, Charles B. Brown, and John W. Robinson.' The bid should be signed in the firm name without a seal. When corporations bid, the bid should be signed with the corporate name by some person duly authorized to do so (evidence of whose authority should be appended), and sealed with the corporate seal.

"6. Bidders should satisfy the United States of their ability to furnish the material and perform the work for which they bid.

"7. Reasonable grounds for supposing that any bidder is interested in more than one bid for the same item will cause the rejection of all bids in which he is interested.

"8. Bids submitted by different members of the same firm or copartnership will not be considered.

"9. The right is reserved to reject any or all bids, and to waive any defects.

"10. All bids must be inclosed in an envelope indorsed 'Proposals for ,' and then inclosed in another envelope and directed to the '

"11. All bids will be publicly opened at the time specified in the advertisement. Bidders are invited to be present and witness the opening of the bids.

"12. The form of contract to be entered into may be seen at this office. Bidders are to be understood as accepting the terms and conditions contained in such form of contract.

"13. The plans and specifications, together with these instructions, will form part of the contract.

"14. Should the bidder to whom the contract may be awarded fail to enter into contract within ten days after notice is given him that his bid has been accepted, he will be considered a defaulting contractor, and recommendation will be made to the Secretary of the Treasury that thereafter no proposal of his be considered.

"15. Bond, with two sureties, in the sum of $, will be

required for the faithful performance of the contract. Each surety will be required to qualify in double the amount of the bond.

"16. A firm will not be accepted as a surety, nor will a partner be accepted as a surety for a copartner, or for a firm of which he is a member. An officer of a corporation will not be accepted as surety for such corporation. In no case will a married woman be accepted as a surety.

"17. No bid will be accepted or contract entered into until approved by the Light-House Board.

"18. Transfers of contracts, or of interests in contracts, are prohibited by law.

"19. Payment for the will be made upon the certificate of the agent of the Board that it has been completed and delivered according to contract.

"20. The must be completed and delivered on or before the day of , 189 , and for each and every day's delay in completing and delivering it beyond that date the sum of $ per day will be forfeited, the forfeiture to be enforced at the discretion of the Secretary of the Treasury."

Opening of Proposals.—"All the bids shall be opened publicly at the time and place specified in the advertisement; each one shall be read aloud as it is opened, and the name of the bidder and the terms noted in the regular order in which they are read. When all the bids shall have been opened, read aloud, and duly entered, an abstract thereof, together with the original bids, shall be submitted to the Board, accompanied by such explanation as may be necessary to a correct understanding of them, and by a designation of the bid which, in the opinion of the advertising officer, should be accepted. In all cases where bids are recommended for acceptance, the officer making the recommendation shall state, whenever the nature of the case will admit of such statement, that the prices named in the bid so recommended for acceptance are advantageous for the Government and not in excess of the current market rates for the labor, material, or supplies, etc., specified at the locality where proposed to be furnished. No bid shall be opened before the hour stated in the advertisement, and bids received after the time prescribed for opening the bids has passed, shall be forwarded to the Board by the advertising officer, with full explanation as to when and how received, whether by mail or messenger, and with such recommendation as to the officer shall seem proper; and in cases where such bids have been received by mail, the wrappers enclosing them showing the post-office marks shall be forwarded to the Board." (L. H. R. 133.)

Specifications.—"To guard against the presentation of claims for extra work or materials under contracts, care must be taken to include in the specifications all items of materials and work that can be anticipated, and to add a covering clause to embrace all omissions." (L. H. R. 139.)

Contracts.—"No bid shall be accepted or contract entered into except by the authority of the Board." (L. H. R. 134.)

"During the progress of a work, should it be found necessary to make changes of any kind not provided for in the contract, the facts shall be reported to the Board, and if the changes be authorized a new contract will be entered into to cover them." (L. H. R. 137.)

"Written contracts for materials and labor shall be made in all cases not specially excepted, and in conformity to the directions of the Board." (L. H. R. 138.)

"No contract can be made transferable. Contracts must be executed to the entire satisfaction of the agent of the Board, and the contractor, with his sureties, will be held to his legal responsibilities, and to him or his legally appointed attorney all payments will be made." (L. H. R. 140.)

"Contracts shall be entered into with the lowest responsible bidders and purchases made at the lowest prices for the proper articles. But when the lowest bid is considered too high it will be rejected, and the facts of the case reported to the Board for instructions." (L. H. R. 141.)

"All contracts shall be drawn and executed in quadruplicate, with two witnesses to the signature of each party, and transmitted to

the Board. . . . No contract shall go into operation until it shall have been duly approved by the Board." (L. H. R. 142.)

"Contractors shall give bonds, with sufficient security, for the exact performance of their contracts. There shall be inserted in each contract an express condition that no member of Congress shall be admitted to any share or part of such contract or agreement, or to any benefit to arise therefrom." L. H. R. 143.)

The official directions as to the execution of contracts are as follows:

"DIRECTIONS AS TO EXECUTION OF CONTRACTS.

"1. The papers should be made in quadruplicate, and each copy should be the exact counterpart of the others, so that any one of them may be used as an original.

"2. Before signatures are appended to the papers, all dates should be written in, and all remaining blank spaces ruled out, with ink.

"3. Interlineations and erasures are to be avoided when possible; but when they are unavoidable, either in the specifications, the contract, or the bond, they should be noted, word by word, immediately above the signature of the witnesses, specifying the number of each line where they occur; and certificate should be made that each specific correction or alteration was made before the contract was signed.

"4. The full name of each signer of contract and bond, and the residence of each surety and witness, should be given.

"5. When firms contract, the name of the firm and the full name of each member thereof should be written at the beginning of the contract; for instance, 'Smith, Brown & Co., of the city of New York, a firm composed of John S. Smith, Charles B. Brown, and John W. Robinson.' The contract should be signed in the firm name, without a seal. The bondsmen must not sign the contract.

"6. When an *incorporated* company enters into contract, the corporate name of the company should be written at the beginning of the contract and bond; for instance, 'The Smith and Brown Dredging Company, a corporation created by and existing under the laws of the State of New York, of the city of New York, in said State.' The contract and bond should then be signed with the corporate name by a person duly authorized to do so, sealed with the corporate seal, and a certificate, under the corporate seal of the company, showing the signer's authority to sign sealed instruments in its behalf, should be appended to one copy of the contract. In cases where a corporation, or other body organized under law, has no seal, that fact, together with the authority of the person who signs in behalf of the organization, should be shown by affidavit made before a notary public, whose notarial seal should be affixed or impressed.

"7. Bond and security for the faithful performance of the contract will be required.

"8. A firm will not be accepted as a surety, nor will a partner be accepted as a surety for a copartner, or for a firm of which he is a member. An officer of a corporation will not be accepted as surety for such corporation. In no case will a married woman be accepted as a surety, and when an unmarried woman (widow or spinster) is given as a surety, she must be described as such in the body of the bond.

"9. The contractor, and two competent sureties, should sign each bond. Each member of the firm should sign the bond personally or by attorney; in the latter case, a certified copy of the power of attorney under which the signature is made should be appended to the contract. Each surety must qualify in double the amount of the bond. When the required oath is taken before a justice of the peace, a certificate in the usual form should be appended, attesting his official character. This inconvenience can be avoided by having the oath taken before a notary public, in which case the notarial seal must be affixed or impressed. The sufficiency of such surety to meet double the entire obligation of the bond should be certified by an officer of the Government known to the Treasury Department. An

officer having a seal, such as a collector of customs or of internal revenue, is to be preferred, when accessible.

"10. An adhesive seal should be affixed to the signature of each principal and surety upon the bond, and the bond should bear the same date or a date subsequent to that of the contract.

"11. When contracts and bonds have been thus prepared, and signed and sealed by the officer making them in behalf of the United States, they should be forwarded to the Board for approval.

"12. When approved by the Board and by the Secretary of the Treasury, two copies will be returned, one for delivery to the contractor and the other for file.

Purchases in Open Market.—"When the public exigency demands that purchases in open market be made, the purchasing officer will, if time permit, request the principal dealers in the articles needed, who may be within his reach, to submit written sealed proposals for the sale of the supplies required. This may be done by handbills posted in public places, by circular letters to dealers, or by both these means combined. . . .

"In case time does not allow even this course to be pursued, purchases in open market may be made in the manner usual among business men. In this case a statement must be forwarded with the account to the effect that the public exigency required an immediate delivery." (L. H. R. 181.)

*"In inviting proposals by circular letters, the Department requires that such letters be sent, if practicable, to at least three actual dealers to secure due competition, and prevent any unjust discrimination. . . . The Board is empowered to authorize that work be done by hired labor, and to authorize the purchase of materials under existing contracts; also to authorize that work be done by hired labor, and to authorize the purchase of materials in open market, for amounts not exceeding $500. for materials. The formal approval of the Secretary of the Treasury is required for the purchase of materials in open market for amounts exceeding $500. . . ." (Extract from circular letter, Light-House Board, June 22, 1894.)

Payments.—"No work done or materials furnished under contract shall be received or paid for until inspected and accepted by an authorized agent of the Board." (L. H. R. 136.)

In work done by contract the times and proportions of partial payments are named in the papers forming a part of the contract. A specific penalty is also named for each day's delay in completing the contract beyond the day fixed for such completion.

"No advance of public money shall be made on account of any contract or agreement, nor shall payment be made on any contract for the performance of any service, or the delivery of any articles of any description, beyond the value of the service rendered or of the articles delivered previously to such payment, according to the terms of the contract." (L. H. R. 148.) (See also Sec. 3648, R. S., and Treasury circ. of Nov. 10, 1886, p. 5.)

"All disbursements shall be made and accounts kept and rendered in accordance with the rules, regulations and instructions of the Light-House Establishment on the printed forms provided by the Board. . . ." (L. H. R. 156.)

"Every appropriation shall be charged with the expenditures made under it; and under no circumstances shall the expenditures on account of one appropriation, or under one head of appropriation, be charged to another." (L. H. R. 159.)

"All vouchers shall show at their head the appropriation on account of which the expenditure is made, and, if possible, shall be paid within the month or quarter in which the liability was incurred." (L. H. R. 161.)

"Vouchers according to the printed forms, consisting of explicit bills and receipts, with certificates attached, showing the nature, quantity, cost, and any other fact necessary to a clear understanding of the transaction, shall be taken for all purchases and expenditures, except those for labor. Prices shall be stated in Federal money and the quantities, as far as practicable, according to the United States stan-

* See pp. 109–111.

PLATE XXXIV.

FORT POINT LIGHT-HOUSE, GALVESTON, TEX.

dards of weights and measures. When articles furnished by different persons are included in one voucher, the bills of items of the several persons shall be receipted and attached to the voucher as subvouchers." (L. H. R. 165.)

"Receipts must not be given or taken in blank for public money or property; but be made out in full, with the exact amount of money, or article or articles of property, written out before being signed." (L. H. R. 171.)

"All receipts for money disbursed on account of the Light-House service must be signed by the individual or copartnership firm entitled to the payment, or by his or their lawful attorney, administrator or assignee. If by attorney, administrator, or assignee, the power of attorney, an attested copy of the letter of administration, or the evidence of assignment, as the case may be, must accompany the voucher. If the receiver make his mark, it must be attested by one or more competent witnesses." (L. H. R. 172.)

"Expenditures for labor, for the wages of crews of light-vessels, supply vessels, and tenders will be exhibited on separate pay-rolls. The rolls must show the name, occupation, rate of pay per day, month, or quarter, as the case may be, the beginning and end of service, and the number of days or months paid on the roll, with a certificate declaring that the services charged were performed and necessary for the objects to which they were applied." (L. H. R. 168.)

"Mechanics and laborers employed by the day shall be paid for the actual number of days' work performed by them. When employed by the month, they shall be paid on discharge *pro rata* for the number of days." (L. H. R. 170.)

"When purchases are made or work is done bills therefor shall be made out, certified to by the officer making the purchases or superintending the work, and be paid on presentation to the disbursing officer." (L. H. R. 180.) (This relates to acts of officers of the Light-House Establishment who are not disbursing officers.)

TREASURY DEPARTMENT PUBLIC WORKS, LIGHT-HOUSES AND BEACONS.

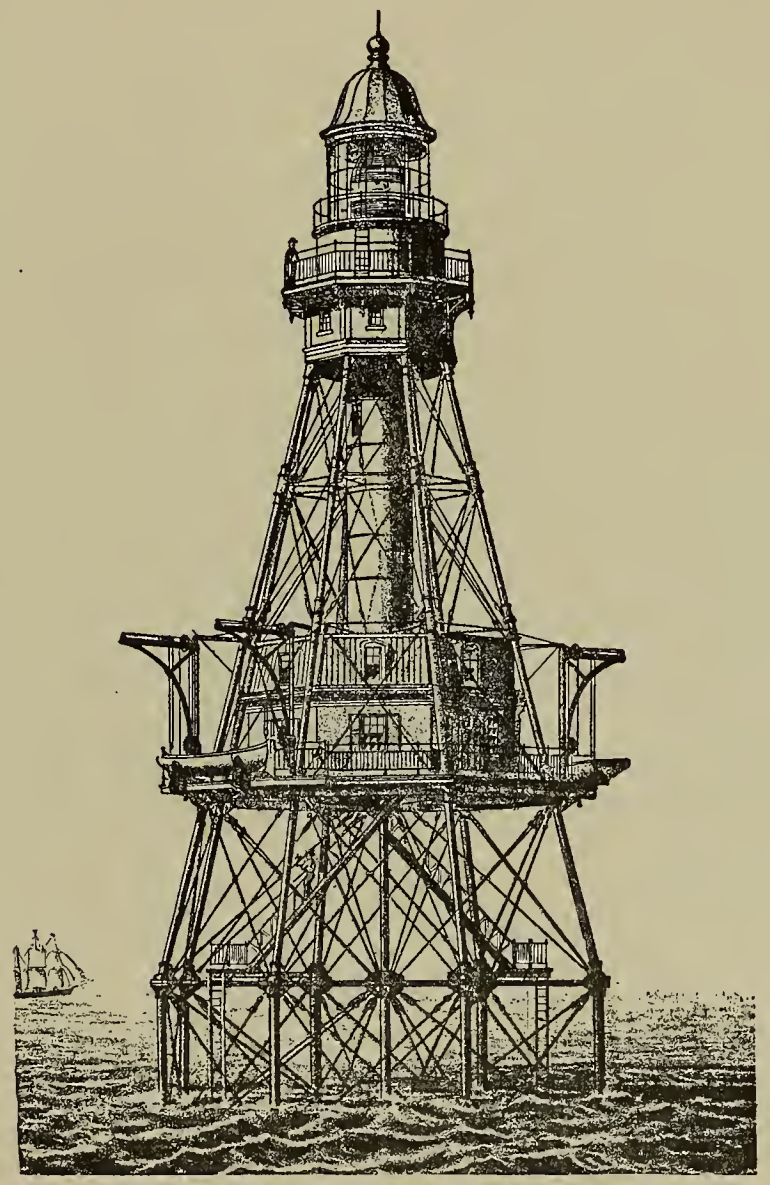
Skeleton Towers, in Water — Iron Pile Light-Houses. — Plate XXXIV and Fig. 9 show typical works of this class. They are used most extensively in southern waters, on soft bottom, and where they are not exposed to running ice. As they oppose comparatively little surface to wave-action, they can be used in very exposed positions. The lowest platforms are placed above the reach of solid water. The horizontal cross-sections of these towers are square, hexagonal, or octagonal. One column is placed at each angle of the figure and one in the centre. The solid constructions supported by the frame comprise a keeper's dwelling and a tower containing a service-room, a watch-room and the lantern. The columns are braced and tied as shown. The lowest members of the Fort Point Light, shown in Plate XXXIV are screw-piles, driven in about 6′ of water.

The following account of the construction of Fowey Rocks Light shows the construction methods generally used.* This Light is situated at the extreme northern point of the Florida reefs, off Key Biscayne Bay, on the south-east coast of the Florida peninsula. It stands on the coral rock, in about 3′ of water. Deep water extends to within 300 yards, and in north-east gales the light is exposed to waves from the full fetch of the Atlantic ocean. The lower series of piles were placed in the summer of 1876. This series consists of nine solid wrought-iron piles, 12″ in diameter, one in the centre and eight on the perimeter, at the angles of a regular octagon, the diameter of the circumscribing circle of which is 48′. They were placed from a working platform, 80′ square, 12′ above the water, resting on iron-shod mangrove piles, driven 5′ into the coral. A pier was built from this platform to deep water. The iron piles were pointed, and were driven by a 2000-lb. hammer raised by a portable engine. The

* This description is compiled from "The Modern Light-House Service" by Arnold Burges Johnson, Chief Clerk, United States Light-House Board, to whom the author is indebted for much other information relating to the Light-House Establishment and its work

rock was first levelled at the site of each pile. A heavy, annular, cast-iron foundation disk, provided with lugs to receive the ends of

FIG. 9.



Light-House on Fowey Rocks, Fla.

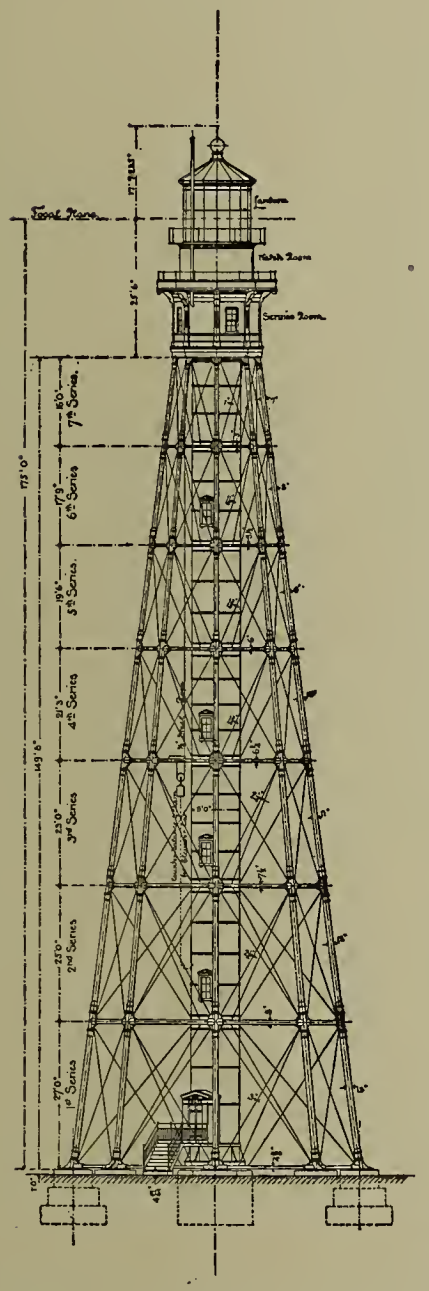
the ties, was first carefully placed for the centre pile, and this pile was driven until a shoulder on the pile was brought to a bearing against the disk. A perimeter disk was then carefully placed at a gauged distance from the centre disk, and the corresponding pile driven. The disks for each of the other perimeter piles was placed at gauged distances from the centre disk and from one of the perimeter disks, and the corresponding piles driven. Each pile was kept accurately vertical while being driven by means of a purchase attached to its head, and was plumbed after each blow of the hammer. The penetration into the coral for each blow of the hammer, with an average fall of 18′, was from $\frac{1}{2}''$ to $1\frac{1}{2}''$. The penetration of the piles is about 10′. After all were driven, their tops were cut off in a horizontal plane, 11′ above the water-surface. They were then capped with heavy castings, which for each perimeter pile had on top an inclined socket for the base of the column of the second series, and on its sides, pockets for three horizontal braces and lugs for six inclined ties. The cap for the centre pile was similarly arranged. Horizontal braces were then placed around the perimeter and from each perimeter pile to the centre, an inclined tie was run from the centre foundation disk to the cap of each perimeter pile, and other ties from each perimeter cap to the foundation disks of each adjoining perimeter pile, and from each perimeter disk to the centre cap. The remainder of the structure was then built. The main platform is about 33′ and the light about 111′ above the water. The work was finished and the light established in 1878.

When screw-piles are used, the pile is placed first and the disk slipped on over it. When the pile is in place, the disk is secured against the bottom by means of a screw with a cutting-point, which passes through a collar on the disk and is forced into the pile. Where the bottom is of soft sand which is liable to scour under the action of the currents induced by the piles, the site is protected by riprap.

In the skeleton tower at the mouth of Delaware Bay, where there is at times much drifting ice, the lower systems of ties are not used, and the tower is further protected by an ice-breaker of screw-piles.

Skeleton Tower on Land.—Fig. 10 shows a typical tower of this class. It is octagonal, and is supported by the eight columns and the central cylinder. The columns are 20′ 3″ apart at the base and 5′ 10″ apart at the top. The cylinder, which is 9′ in diameter, contains a winding staircase and an elevator. At the top of the tower there is a service-room, a watch-room, with gallery, and the lantern.

FIG. 10.



The cylinder foundation pier is of concrete, 14′ square and 10′ high, with its top 1′ above the ground. The perimeter piers are of concrete, 12′ square at the lower base, stepped in to 7′ 4″ at the upper base. They are also 10′ high. Buried in the concrete of each, 8″ above the base, are three ribbed anchoring-plates, each 18″ square, to which the foundation disks are bolted. The foundation disks are heavy castings, which have on top inclined sockets for the columns, three pockets for the horizontal members, and three lugs for the inclined ties.

The ties are of wrought iron, and are arranged similarly to the ties of the iron-pile lights. They are held by keyed steel pins passing through eyes at the ends, and are tightened by turnbuckles. In the centre of the frame they are attached to belts on the cylinder. The horizontal members at the base are of wrought iron, fastened in the pockets by steel keys.

The columns are hollow castings. Each column is in seven sections, joined by cast sockets, provided with lugs and pockets for the reception of the struts and ties. The columns are required to be perfect castings, true to line and with even thickness of walls. The wall thickness varies from 3″ in the lowest series to $1\frac{1}{2}$″ in the seventh.

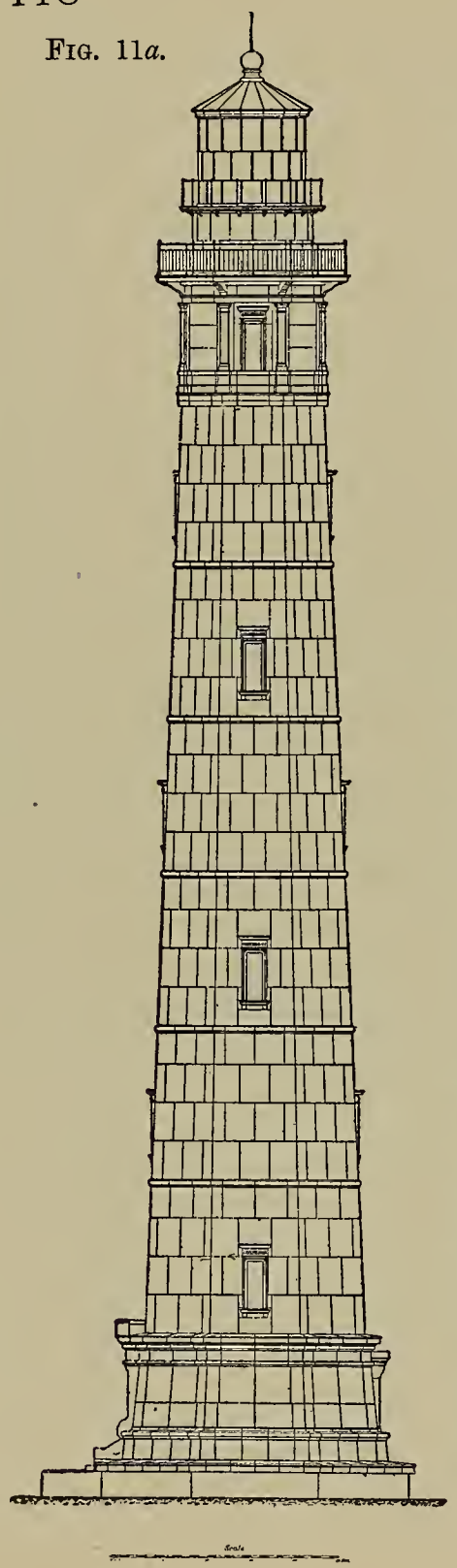
The struts above the lowest series are also hollow castings, uniform in metal thickness. Each is cast in two sections, one with a male and one with a female flange, which are bolted together after the strut is placed.

The cylinder is built up of cast plates. Between the belts these are $\frac{1}{2}$″ thick, 7′ $2\frac{5}{8}$″ high, and $56\frac{1}{4}$″ wide, with flanges and ribs. The belts are cast in sections.

The architrave at the top of the columns is composed of eight corner and eight side castings, bolted together, and secured to the columns by sockets in the corner castings. The floor-beams of the rooms are rolled I-beams. The tower walls are castings. All of the bearing faces of the castings throughout are planed or turned smooth and true, and the bolt-holes are bored. The service-room is lined and floored with wood.

Materials.—All wrought iron used in the structure must be tough, ductile, fibrous, and of uniform quality. When tested in specimens of uniform sectional area of at least $\frac{1}{2}$ square inch, taken from members which have been rolled to a section of not more than $4\frac{1}{2}$ square inches, the iron shall show a minimum ultimate tensile strength of 50,000 lbs. per square inch and a minimum elongation of 18 per cent in 8″. Specimens taken from bars of a larger cross-section than $4\frac{1}{2}$ square inches will be allowed a reduction of 500 lbs. for each additional square inch of section, down to a minimum of 48,000 lbs., and have an elongation of 15 per cent in 8″. All wrought iron must bend cold without cracking through 90 degrees to a curve whose radius is not more than the thickness of the piece.

FIG. 11*a*.



The steel may be either open-hearth or Bessemer. Specimens for testing, planed or turned to a cross-section of about $\frac{1}{2}$ square inch, must have an ultimate tensile strength of from 54,000 to 62,000 lbs. per square inch, and a minimum elongation of 25 per cent in 8″. The steel must bend, cold, flat on itself, without a sign of fracture.

Sample castings, 1″ square, cast from the same heat of metal in sand moulds, must be capable of sustaining on a clear span of 12″ a central load of 2250 lbs. when tested in the rough bar. The iron must be light gray in color, close-grained, not too hard, and uniform in shrinkage.

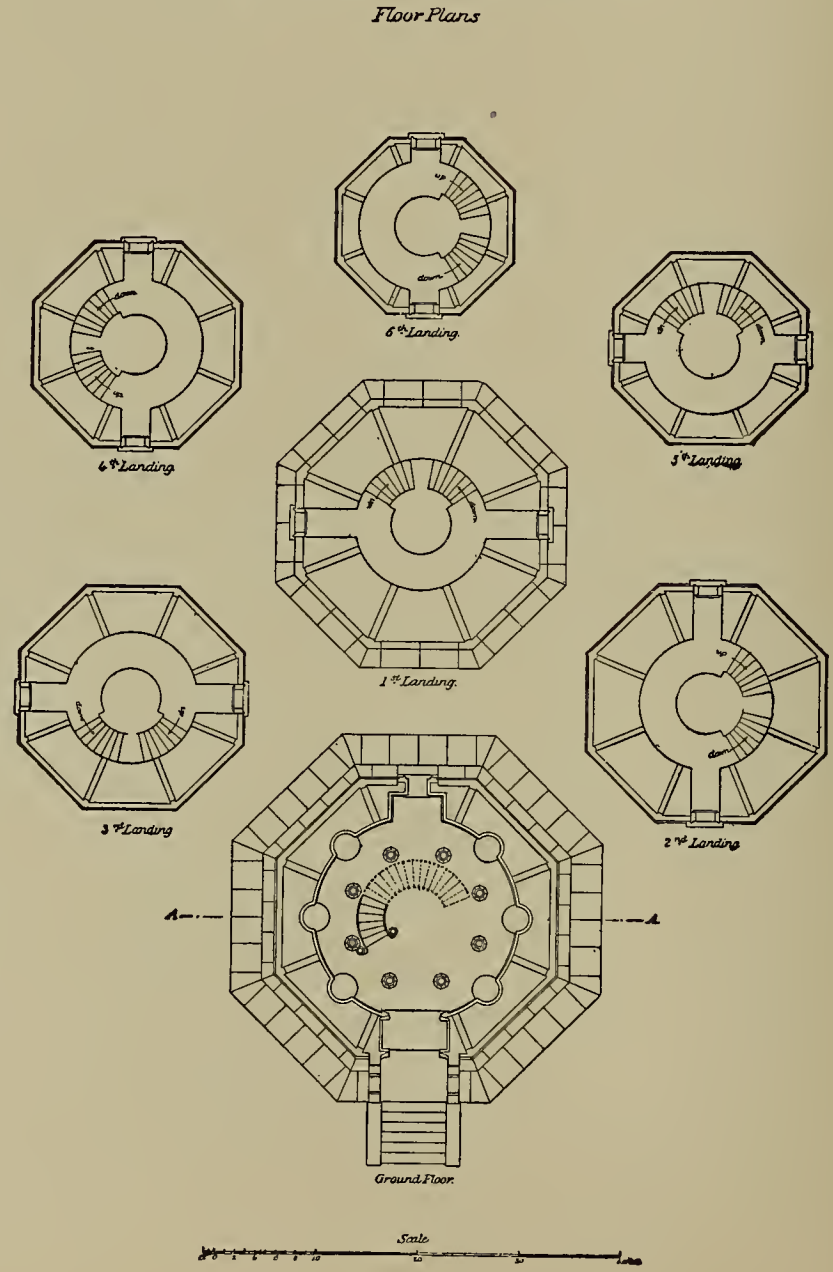
Contracts for furnishing and erecting two towers of this kind, one at Cape Charles, Va., and one at Hog Island, Va., were made in 1893. The contract price for both was $78,200.

Cast-iron Tower on Land—Light-House at Cape Henry, Va. This type of structure is designed for sites where there is difficulty in obtaining and transporting materials and where there is a possibility that the position of the light-house must be shifted later, on account of encroachment by the sea.

The tower is shown in Fig. 11. It is a frustum of an octagonal pyramid, resting on a base of similar form. It is made up of an outside shell, or "mantel," of cast iron and an inner cylinder of

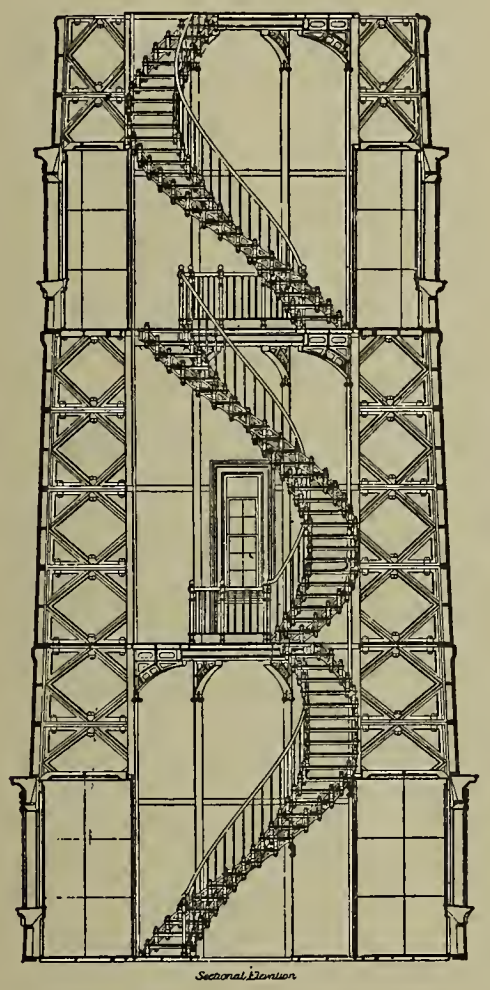
FIG. 11*b*.

Light-House for Cape Henry, Va.



wrought iron, the two being connected by eight radial abutments. The space between the two shells at the base is utilized for storage purposes, and, above, it can be reached through manholes in the recesses of the tower windows. Ventilation there is secured by openings in the base and others under the lantern gallery. The height of

FIG. 11*c*.

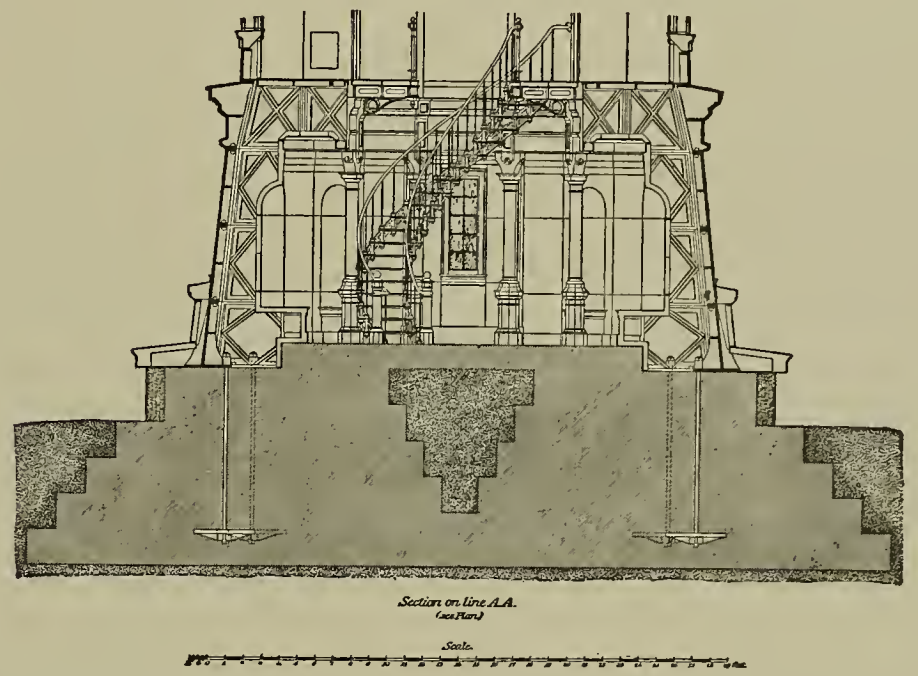


the tower from the base to the focal plane is 150′. The foundation is of concrete, 12½′ thick. The lower tier of the mantel castings and of the radial abutment frames is fastened to the concrete foundation by bolts, secured to anchor-plates buried 9′ in the concrete.

The mantel is made up of tiers of cast-iron plates, with webs which vary in thickness from 1¾″ in the base to ⅞″ in the sixth story, and flanges, generally ¼″ thicker, assembled with wrought-iron screw-bolts, of the same diameter as the thickness of the flange.

Each abutment is built up of twenty-eight cast, flanged frames, four in the base, and four in each of the six stories. These are bolted to each other and to the outer and inner shells. The floor-

FIG. 11*d*.



plates of the stories of the shaft rest on the broadened flanges of the top abutment pieces of the story next below.

The inner cylinder is made of ¼″ boiler-iron plates, connected to each other horizontally by butt-strips and rivets, and vertically by butt-strips and bolts, which at the same time secure the inner cylinder to the abutment pieces.

The service-room floor, above the shaft, is supported on two rolled I-beams. Its walls are of castings, and are lined with ⅛″ sheet

iron. The watch-room is above the service-room. Its floor rests on three rolled I-beams. Its walls are of castings. The main gallery encircles the watch-room, and is supported on cast brackets attached to the service-room walls. The lantern is above the watch-room, and is encircled by the lantern gallery, which rests on brackets attached to the watch-room walls. The lantern frame is of steel. The roof is of copper, supported on a cast crown-piece and cast-iron rafters.

The wrought iron is of a quality that will bear a tensile strain of not less than 55,000 lbs. per square inch. The castings were made in either green or dry sand, and were capable of standing a tensile strain of not less than 18,000 lbs. per square inch. Throughout the structure, all the surfaces of contact, connected by bolts, were made true by either turning or planing. All screw-bolts were smooth, true forgings, or were turned. All screw-bolt holes were accurately drilled. The bolts were made according to the Franklin Institute standard, and were so spaced in the mantel and abutment pieces that there are at least four bolts in each joint-flange of a casting.

Weight of cast iron in tower	1,278,900 lbs.
" " wrought " "	62,800 "
" " brass " "	1,020 "
" " copper " "	930 "
" " steel " "	2,700 "
Total weight of tower.....	1,346,350 "

Towers on Iron Tubular Foundations.—Front Beacon, Craighill Channel, Baltimore Harbor Entrance.—This type is used at sites which are exposed to the pressure of masses of floating ice or of drift. The light at this beacon was established in 1873, but the permanent structure was not completed until 1875. It is a cylindrical iron tower, resting on a cylindrical iron base filled with concrete. The base consists of two portions, one 12′ high, having the form of a frustum of a cone, 30′ in diameter at the base and 24′ at the top. The upper portion is a cylinder 24′ in diameter. The cylinders are built up of sections each composed of 24 cast plates, which are bolted together through flanges. For the height between planes 2′ below low water and 2′ above high water, respectively, the web of the cylinder is 2″ thick. In the other parts it is $1\frac{1}{4}$″ thick.

As the bottom of the bay at the site is very soft mud, a foundation was first prepared by driving a cluster of piles over the site, and cutting off their tops at a uniform level of 24′ below mean low water.

While the pile sub-base was being prepared, the lower portion of the cylinder was assembled in a secure location about ten miles away from the site. A platform, or grillage, of four layers of 12″ timber was built. The lower section of the cylinder was bolted to it, and the cylinder was built to a height of 30′, measured from the bottom of the grillage. This was filled with concrete to a height of 3′. The caisson thus made drew 15′ of water. It was towed to the site and moored accurately over the foundation-piles. A strong box, 12′ square and 22′ high, was built over the centre of the concrete, and this was filled with gravel and the caisson was sunk in place. Riprap was placed immediately around and outside of the base, more concrete placed in the caisson, the gravel and box removed, the caisson filled with concrete, and the tower finished.

Fourteen-foot Bank Light-House, Delaware Bay.—This light has a cylindrical foundation, expanding, trumpet shape, under the main gallery, like that of the Craighill Channel Beacon. This foundation-cylinder is surmounted by a two-story, masonry dwelling with gable roof, having a tower surmounted by a lantern rising from the east side of the dwelling. The light was established in 1886. The following description of the method of placing the foundation-cylinder is taken mainly from the report of the Light-House Board for 1888:

A caisson of 12″ × 12″ timber, about 40′ square, 5′ thick, and with a cutting-edge 7′ deep, was first built. It was lined and the joints were filled with mineral pitch, so as to be water-tight. An air-shaft led from the deck to the working chamber formed by the cutting-edge. On this caisson the foundation-cylinder, 35′ in diameter, was started. It is built in courses, each about 6′ high, and contain-

GILL ENG CO.,N.Y.

FRONT BEACON, CRAIGHILL CHANNEL, BALTIMORE HARBOR ENTRANCE.

ing thirty-six $1\frac{1}{2}''$ plates. When it had been built to the height of 18′, it was towed by two tugs to the site of the light, twenty miles away. Its displacement was about 400 tons and its draught about about $15\frac{1}{2}'$.

When over the site, water was admitted into the cylinder and the cylinder sunk to the bottom. It did not rest vertically, and there was danger of an overturn. A supply of stone ballast was promptly placed on the higher side, and the cutting-edge of the caisson forced into the bottom, until the cylinder was vertical. The process of sinking was then carried on in the usual manner by the plenum-pneumatic process. The work of excavation was carried on by three gangs of workmen, and the rate of sinking was from one to two feet in twenty-four hours. Work was stopped when the caisson had penetrated to about 33′ below the original surface of the shoal. The air and working chambers were filled with sand, and the cylinder with concrete to within 10′ of the top. The total height of the cylinder is 73′ and its top is 30′ above the low-water level. The stone arches of the foundation of the dwelling and tower spring from the surface of the concrete. 6000 tons of riprap were placed around the cylinder to protect it against scour.

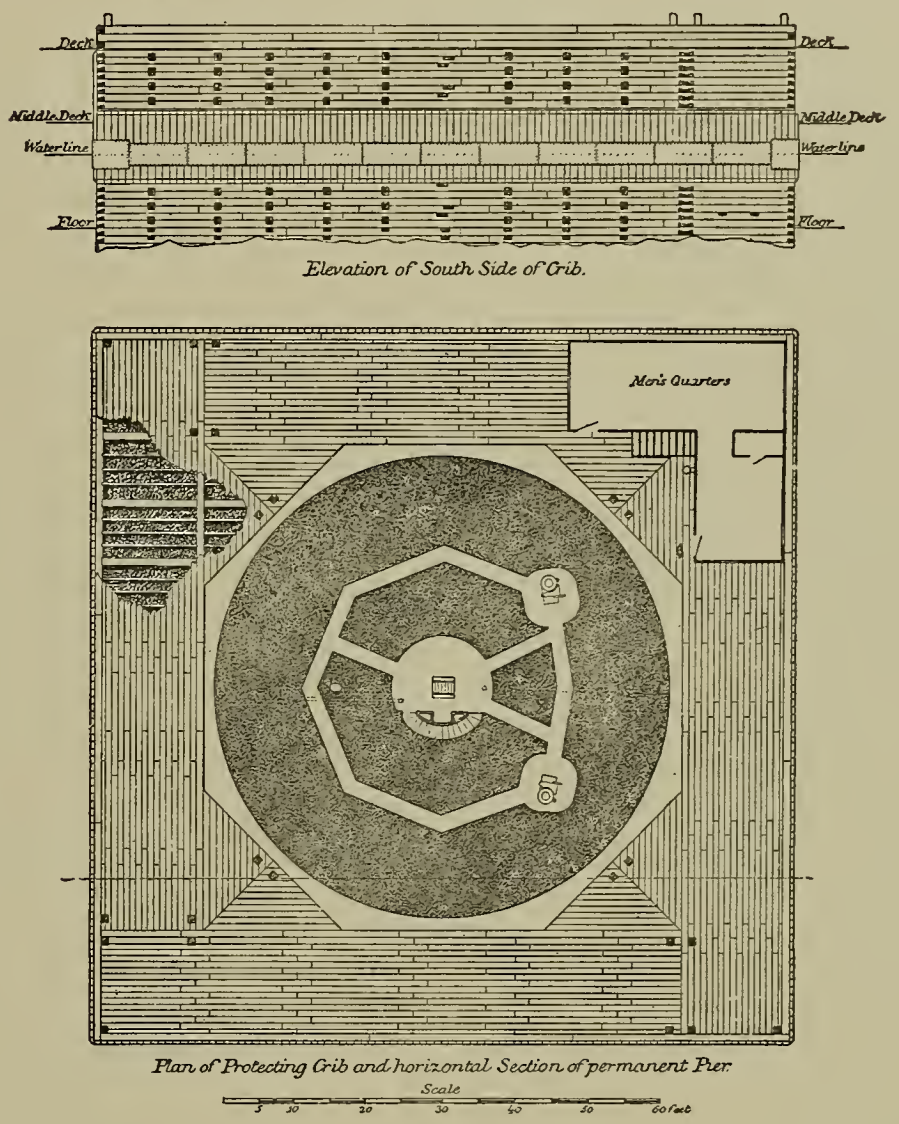
The total cost of this light was $124,000.

Stannards Rock Light-House, Lake Superior.—This light is situated about 45 miles from Marquette. It was established in 1882. It is a conical, gray-stone tower on a cylindrical pier of iron filled with concrete. The light is 101′ above the lake level. The cost was $285,000. The cylinder is of $\frac{1}{2}''$ wrought iron, built in five courses, each of eighteen plates, and is 62′ external diameter at top and 62′ 4″ diameter at the bottom. The height is from 28′ to 30′, with its deck 23′ above the lake surface, covered with small stone blocks set in cement mortar. The cylinder rests on trap-rock which has an irregular surface, seamed and fissured.

The cylinder was placed as follows: A crib pier $97\frac{1}{2}'$ square, filled with stone, and having an octagonal well, 66′ across, in its centre, in which the permanent pier was to be built, was first placed around the site, as shown in Fig. 12. To construct it, three courses of the pier were framed and assembled at Stannardsville, Lake Superior, about 50 miles from the site, the nearest favorable harbor. This formed a raft, 3′ thick, which was launched and another course

FIG. 12.

Stannards Rock Light-House, Lake Superior.

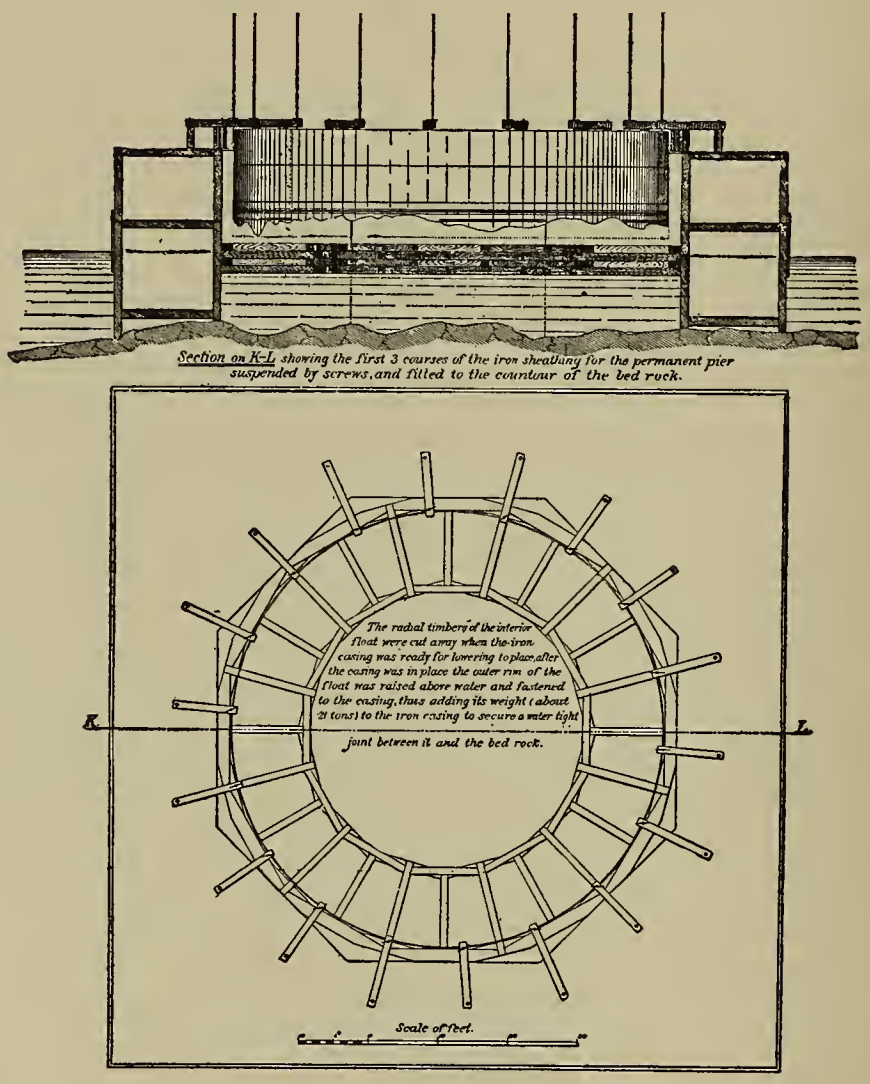


bolted on. The raft was then towed to the site and moored accurately in place. About 1000 soundings were then made along the lines of the timbers, and the corresponding depths were marked on the timbers. The raft was then towed back to Stannardsville. The bottom of the raft was next planked and shimmed up to conform to the irregularities of the rock. It was then built up to 13′ above the bottom planking, decked over, and caulked so as to make four water-tight compartments, each having an interior area of about 1053 sq. ft. 875 tons (600 cu. yds.) of ballast stone were placed in the pockets, giving the crib a draught of 11′. Scuttling-valves, operated from the deck, were placed in the walls of each water-tight compartment. Two steam-pumps were placed on deck, with suction-pipes communicating with each compartment. Hatches were placed over each pocket and battened down. The crib was then towed to the site by two steamers and one tug, in about thirty-four hours. Arrived at the site, it was scuttled and sunk, but the location not being entirely satisfactory, it was raised, moved, partly turned around, and sunk again. A slight unevenness which developed after settling was corrected by building up the depressed portion. Ten more courses of 12″ × 12″ timber, which had been framed and fitted on shore, were rapidly added to the crib, and more ballast stone was filled in as the timber-work progressed. When completed, the pier contained 4926 tons (3379 cu. yds.) of stone. The pier was then again decked over and left for the winter.

The following spring the iron cylinder for the permanent pier was started on interior framing, as shown in Fig. 13. After having been built to a height of 15′ it was suspended by screws from the top of the pier, and its bottom was cut so as to conform accurately to the rock surface. A canvas tube filled with oakum was then fastened to the bottom edge, temporary stiffening rings of timber were bolted on the inner surface, and the points of the cylinder bottom which were to fit into the holes in the rock were stiffened with temporary wooden shores. The cylinder was then lowered to place and weighted with 21 tons extra weight, in order to force the oakum at the bottom tightly against the rock. The cylinder was then pumped out, the rock surface inside cleaned, the cylinder completed to full height and

FIG. 13.

Stannards Rock Light-House, Lake Superior.



filled with concrete. The stone tower was then built, and an iron lantern erected upon it. The protection pier was removed in 1883.

Preliminary work was begun June 18, 1877. Work stopped for the season Oct. 23, by which time the crib had been built up for nine courses, decked, caulked, and prepared for the winter. Work was resumed May 14, 1878, and stopped for the winter, Oct. 14. The crib was then in place. The season of 1879 lasted from May 6 to Oct. 6. The working party lived on a steamer at the site, and when the work was stopped the iron cylinder was in place and filled with concrete to an average height of 9′ above the water-surface. The season of 1880 lasted from May 5 to Aug. 22, when everything was ready for the stonework of the tower. In 1881 between April 12 and July 4, the masonry-work on the tower was finished. In May, 1882, the ironwork of the tower was set in place.

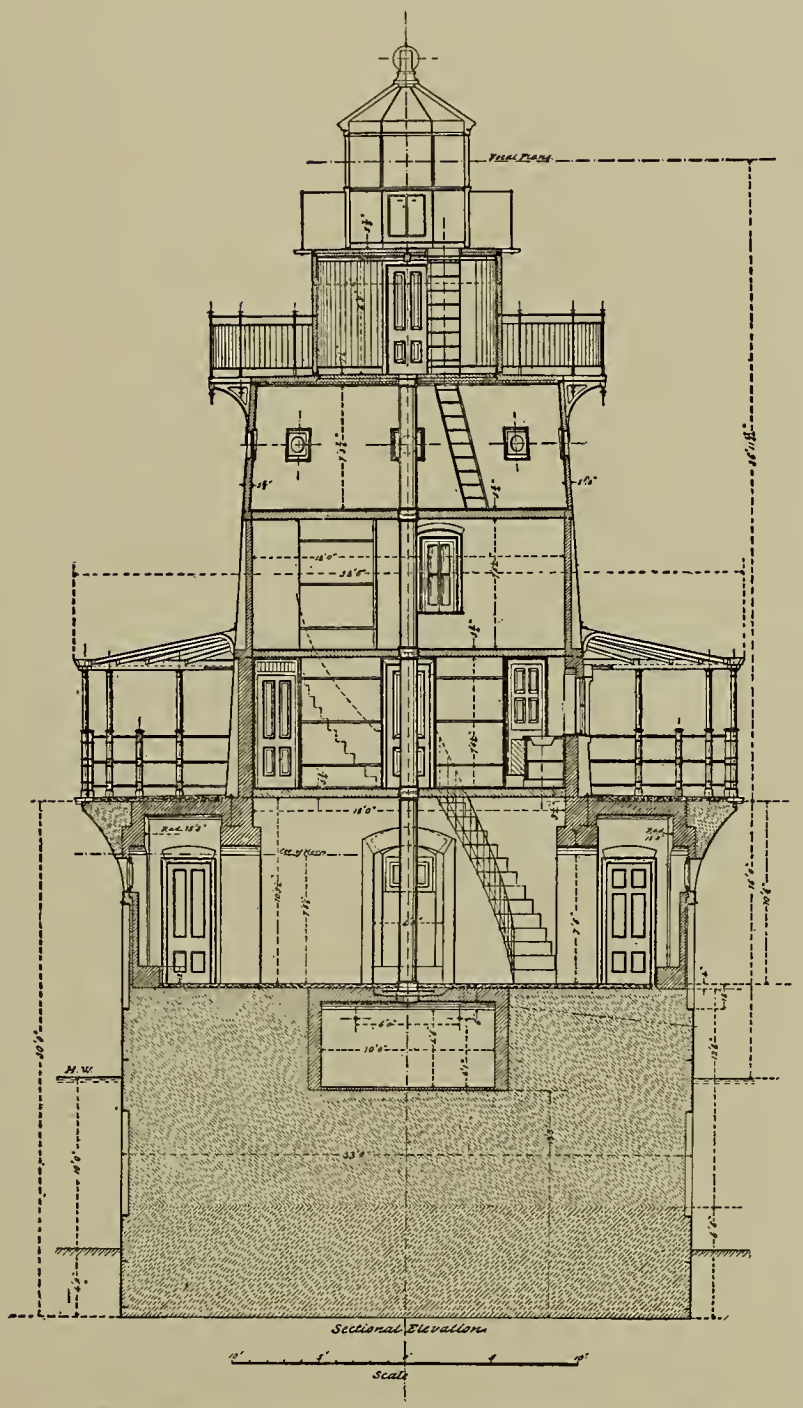
The cost of construction was as follows:

Labor and subsistence	$89,934.35
Transportation	88.091.09
Material	85,002.13
Machinery	6,118,17
Tools and implements	4,869.41
Miscellaneous	10,762.23
Total	$284,777.38

Computed Weight of Materials in the Permanent Pier and Tower.

	Tons of 2000 lbs.
Concrete in the pier	7246
Iron sheathing of pier	78
Stone in the tower	1270
Brick in the tower	76
Ironwork of tower	48
Total	8718

FIG. 14.



Deer Island Light-Station, Boston Harbor, Mass.

A detailed account of this work is to be found in the Annual Report of the Light-House Board for 1882.

Deer Island Light-House, Boston Harbor, Mass. (Fig. 14.)—This light-house consists of a circular foundation-pier, supporting a three-story circular dwelling, a veranda with boat davits, a circular parapet, and an octagonal lantern.

The foundation-pier is a cast-iron cylinder, open at both ends, and trumpet-shaped at the top. It is sunk 4′ in the bottom of the bay. The lower portion of the cylinder for a height of 19′ 2″ from the bottom is filled with concrete, and contains the water-cisterns. The upper portion is lined with a brick wall, and its interior space, the cellar, is divided by one circular and several straight brick walls into the engine-room, water-closet, and store-rooms. The annular space between the brick lining and the circular wall is covered with brick arches, which carry the main gallery floor. The main gallery is reached from the water by ladders. and is covered with an iron roof and surrounded by hand-rails, which, like the boat davits, are fastened to the columns supporting the gutter on the outer edge of the roof. The dwelling is of iron, lined with brick, and has the form of a frustum of a cone. It rests on the circular wall of the cellar, and is divided into three stories by three iron floors, which are supported by the brick linings of the house.

and by centre columns. The dwelling is covered with an iron gallery floor. On this are supported the parapet, the watch-room floor, and the lantern gallery and lantern. A spiral staircase leads from the cellar to the different floors of the dwelling. The watch-room and the lantern are reached by ladders. The roof of the lantern is of iron. The height of the focal plane above mean low water is about 63′.

The foundation-cylinder is 33′ in diameter at the base and 37′ 9″ in diameter at the upper, trumpet-shaped end, and 30′ high. It is made up of 160 plates, arranged in five circular courses, each containing 32 segmental plate castings, so placed that the plates of adjoining courses break joints. The plates of each course and the various courses are fastened together by $1\frac{1}{4}''$ bolts, through vertical and horizontal flanges. Each plate of the 1st, 2d, 3d, and 4th courses is about 6′ high, and 3′ 2.8″ wide, with flanges all around, and a horizontal stiffening rib midway of the height. The four lower courses have webs and centre ribs $1\frac{1}{4}''$ thick, and flanges $1\frac{3}{8}''$ thick. The plates of the fifth course are bent, and widened at the top so as to form the trumpet shape, and are 1″ thick. The plates of the lowest course have a cutting-edge on their lower ends, and sixteen of them have a vertical stiffening rib at the back, and hook-shaped lugs on the outside near the top, for use in lowering the cylinder.

The light-house is located on a hard shoal, composed of gravel, sand, and clay, covered with 6″ of water at low tide. The range of tide is 10′. The specifications for this work called for the following construction methods: The site was to be dredged to a depth of 4′. A temporary platform was then to be built around it, and the cylinder assembled while suspended from it on screws, the ends of which were attached to the lugs of the lowest course. It was to be lowered to place by means of these screws, and filled with concrete. After the work was finished the platform was to be removed, and the shoal around the cylinder cleared and brought to its original height.

The light-house was finished in December, 1889. The cost was about $41,000.

Lubec Channel Light-House, Maine.—This light-house is similar in design to the Deer Island light, just described. It is located on soft bottom, in water 11′ deep at low tide. The tidal range is 17′. The two lower courses of the cylinder were assembled on a mud flat in the vicinity, and floated to the site by the aid of a temporary caisson, and there sunk in place. Four more courses were then added, the cylinder pumped out, and the interior excavated to a depth of 4′. It was then found that the material of the site was too soft to bear the weight of the light-house without a sub-foundation of piles. 185 spruce piles were "driven within the cylinder; 23 of them, forming a ring next to its perimeter, were spliced and driven to a depth of 69′ to a hard stratum of gravel and bowlders; the 162 interior piles were driven in the soft clay to a depth of 35′ to 45′, and the heads of all the piles were driven to, or cut off flush with the surface of the site." (Rep. Lt.-Hse. Bd. 1890.) The cylinder, which had settled to a depth of 6′, was accurately levelled. Concrete was then deposited in it, without removing the water, to a thickness of 14′. The water was then pumped out, and the remaining concrete placed. The entire structure was finished in November, 1890. It cost about $67,000.

Iron Tower on Concrete in Wooden Caisson—Detroit River Light-House.—This light-house is situated in Lake Erie, near the mouth of Detroit River, in 22′ of water. The bottom is quite level, and borings showed that the first 3′ to 4′ is composed of hard limestone, gravel, and sand, very compact, and difficult to penetrate; then 12′ of soft clay and fine sand, easily penetrated; and finally, underlying the whole, a bed of tough, hard blue clay, very difficult to bore.

The foundation-pier is an irregular hexagon in shape, with two sides 46′ long running north and south, parallel, and 44′ apart. Each end is pointed so as to serve as an ice-breaker, and is formed of two sides, each 31′ long, meeting in a right angle. A crib of this form was first built, 90′ long by 45′ wide, of $12'' \times 12''$ timber, having four interior longitudinal and nine cross-walls, which divided it into pockets about 9′ square. It was built on shore to the height of five courses, with a solid bottom of the same-sized timber, thoroughly caulked, and launched. The crib was then built up to full height and

partially filled with concrete while floating at the wharf. In the mean time guide-piles had been driven to insure the accurate placing of the crib. It was then towed to the site, sunk, and filled with concrete to within 4′ of the surface. From this level a wall of rock-face masonry was built around the face to the height of 11′ above the lake surface, and backed with concrete. The top of the pier is covered with 8″ × 14″ stone blocks, set in cement. The crib-walls were removed to the level of the foot of the masonry wall. During construction, the pier settled about 18″ into the bed of the lake. The foot of the pier is protected with riprap.

The light tower and fog-signal house stand on the pier, with cellars below its surface. The house is 22′ × 30′ in plan, and is built of 6″ × 6″ studding, sheathed diagonally on the outside with 2″ plank, and lined with 1″ flooring, the space between being filled with mortar of lime and sawdust.

The tower is a frustum of a cone, 32′ high, forming four stories, surmounted by a main-gallery deck, and a cylindrical watch-room, 10′ in diameter and 8′ high, surmounted by a lantern. The tower is built of cast iron, with a brick lining, 13″, 9″, and 4″ thick, for the first, second, and third stories, respectively, forming rooms 18′ in diameter. The fourth story, watch-room, and base of lantern are lined with $\frac{7}{8}$″ ceiling. The focal plane is 56′ above the lake level. The light was established in August, 1885, work on the crib having been started in March, 1884. The total cost was about $78,000.

Masonry Towers on Land.—These form the most familiar type of light-houses. Body's Island Light-house, North Carolina, a masonry lighthouse, 150′ high, is thus described: * "A secure foundation was obtained by excavating until a bottom of hard, clear sand was reached, 7′ below the surface. On this was laid a grillage of timbers, 6″ × 12″, placed at right angles to each other, in two layers; then followed one course of dimension-stone, 18″ thick; over this coursed rubble was laid in large blocks, thoroughly breaking joints, and all grouted with one part Portland cement and two of sharp sand. From this foundation rises the base of the tower (10′ 2½″ high), the frustum of an octagonal pyramid, with plinth and cornice. The interior 'well' of the tower is lighted by five windows. Access to the watch-room is had by eight sets of spiral stairways, the first seven of which make half the revolution of a spire, the eighth an entire revolution. These stairways are not attached to the tower walls, but are supported by the landings—semicircular iron plates resting on I-beams and a corbelling projecting from the interior face of the tower. There is a hand-rail on each side, and the entire system of stairs belonging to each flight is kept rigid by making the carriers of such a form that each baluster firmly bolts together three contiguous ones. The arrangement of the stairs, by which the encumbrance of a central shaft containing a winding stair is avoided, the interior better lighted, and room gained, is an improvement introduced by Major Elliot (now Colonel). The height of tower from base to focal plane is 150′."

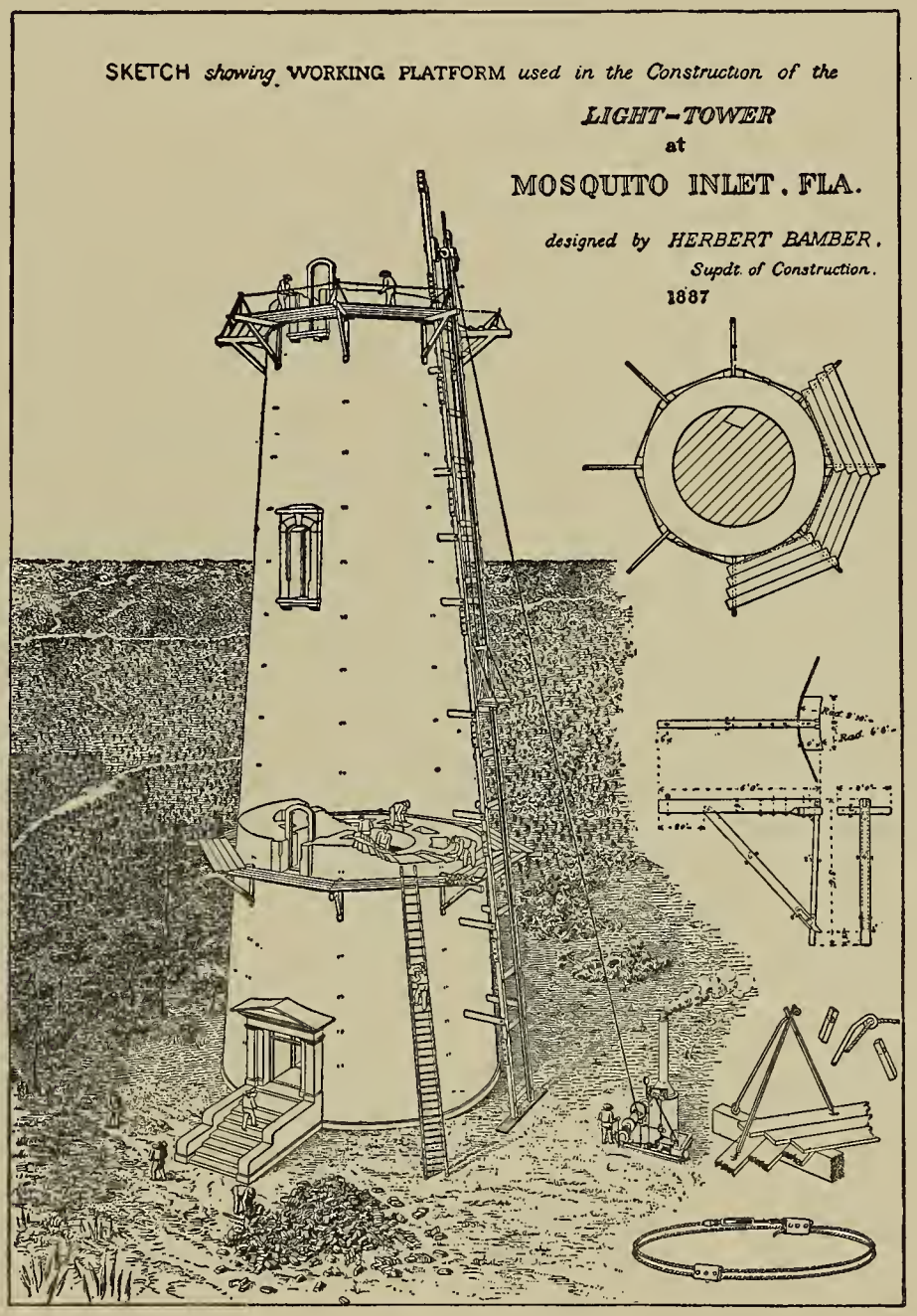
The walls of this light-house above the base are built hollow. As stated, there are eight stories between the base and the service-room floor. The inner shell is uniformly one brick thick. The outer shell decreases in thickness uniformly, from six bricks at the base to two and one half bricks at the cornice, below the service-room. The total thickness of the wall at the base is 5′ 8″. The diameter of the well of the tower at the base is 16′ 8″, and at the cornice 10′ 8″. The outside batter is $\frac{6}{10}$″ in one foot. A similar brick tower at St. Augustine, Florida, cost $150,000.

Working Platform for Building Round Towers.—A simple working platform, or scaffolding, for use in building and repairing towers of this kind, was devised by Mr. Herbert Bamber, Assistant Engineer, and used by him in the construction of the Mosquito Inlet Light-House in 1887. It is shown in Fig. 15, and is thus described in the Annual Report of the Light-House Board for 1887: It "consisted of 2″ planks, 1′ wide and 12′ long, supported by brackets. These supporting brackets were constructed of white pine and bolts, with iron strengthening pieces, as shown in the sketch. To facilitate setting the

* Barnard on Light-Houses. T. A. S. C. E., vol. viii.

brackets on the same level, the irons at the lower angle were made with projections to set into two adjacent cross joints in a headed

FIG. 15.



course of the brick-work, these two joints being left unfilled for this purpose and pointed subsequently. Through the upper angle of the brackets a $\frac{3}{4}''$ galvanized-iron wire rope was passed twice around the tower, and by means of clamps of patent wire rope and a turnbuckle, was stretched taut, and thus made to hold the brackets in position as represented in the sketch. As a precautionary measure, an extra clamp was placed upon the two parts of the wire rope on the side of the tower opposite the turnbuckle."

Other light-houses on land are of varied types. All comprise a tower bearing a lantern and one or more keeper's houses. They are built of wood, iron, brick, or stone, according to their importance and the building material most available. Their construction presents no special features different from other buildings of like character.

Masonry Towers on Reefs—Minot's Ledge Light-House, Boston Bay, Mass.—This light-house is said to rank, "by the engineering difficulties surrounding its erection and by the skill and science shown in the details of its construction, among the chief of the great sea-rock light-houses of the world." It is fully described in all treatises on engineering work of this character. The account of certain details of construction only is therefore given here.

The ledge on which it is founded was bare only at three-quarters ebb, and the greater portion of the foundation of the light lies below low water. The rock was cut into shape to receive and bond thoroughly with the lower courses of the masonry. No permanent coffer-dam could be erected, and in the words of the constructing engineer, General Alexander, "there had to be a combination of favorable circumstances to enable us to land on Minot's Ledge at the beginning of the work—a perfectly smooth sea, a dead calm, and low spring-tides." The working season was from April 1 to September 15. "Work was prosecuted with all possible diligence for more than three years before a single stone could be laid."

There are two partial courses of stone in the foundation below the first full course of masonry. Seven stones form the lowest partial course, all with their bottom beds below low water, in depths

varying from 7″ to 2′. Of the twenty-nine stones of the second partial course, twelve have their beds below low water at depths varying from 4″ to 1′ 2″. To prepare the beds for these stones the men were provided with 1¼″ drills, from 2′ to 4′ long, The ends of a line on which a vertical cut was to be made having been marked, as many holes as possible would be started at low water, about 1″ apart, and carried down to the depth of 2″ to 3″. During a good tide, three men, two striking and one holding the drill, would start from twenty to thirty holes. These holes then became guides in which drilling could be done, even when there were two or three feet of water over the rock. After the holes had been drilled to the required depth, they were "set out," breaking down the walls of rock between them, and isolating the portion of the rock which had to be removed. When this was under water, it was first drilled or plugged off to nearly the required depth, and then cut down to the true surface by means of a tool with a cutting-face similar to a heavy "patent hammer."

In finishing the foundation and in laying the lowest courses of the masonry, temporary coffer-dams were made of 200 to 300 sand-bags, of heavy canvas. These were piled quickly around a limited area, the water within bailed out, and the space kept dry by means of sponges. By such a dam the water could be kept away from a spot for fully half an hour if the sea was very smooth. Later, a scaffold 20′ above low water was built over the rock, on iron posts set into holes. Life-lines were stretched between the posts, two or three feet above the rock. This scaffold was carried away by a wreck during the following winter and was never replaced. An iron mast was afterwards set up on the rock for use as a derrick, for laying the lower courses of masonry.

The mortar used was neat Portland cement. When the stones were set under water the following precautions were taken: "A large piece of thin muslin was spread on a platform on the ledge. A layer of mortar was then spread over it of the required thickness. The stone was then laid on this bed of mortar. The vertical joints of the stone were then plastered with mortar. The cloth was folded up and laid smooth along these vertical joints, cutting away its superfluous parts. After remaining five or ten minutes the mortar would begin to set so that it and the attached cloth would adhere to the stone. The stone was then laid in this envelope, which protected the mortar from the dissolving action of the water while it was being lowered into position."

The machinery and rigging of the derrick had to be removed after each day's work. It was arranged so as to float when cast loose on the water, and thus was easily towed to and from the tender. The stones were cut on shore, and each stone was marked and laid away in the stone-yard in the order in which it would be needed.

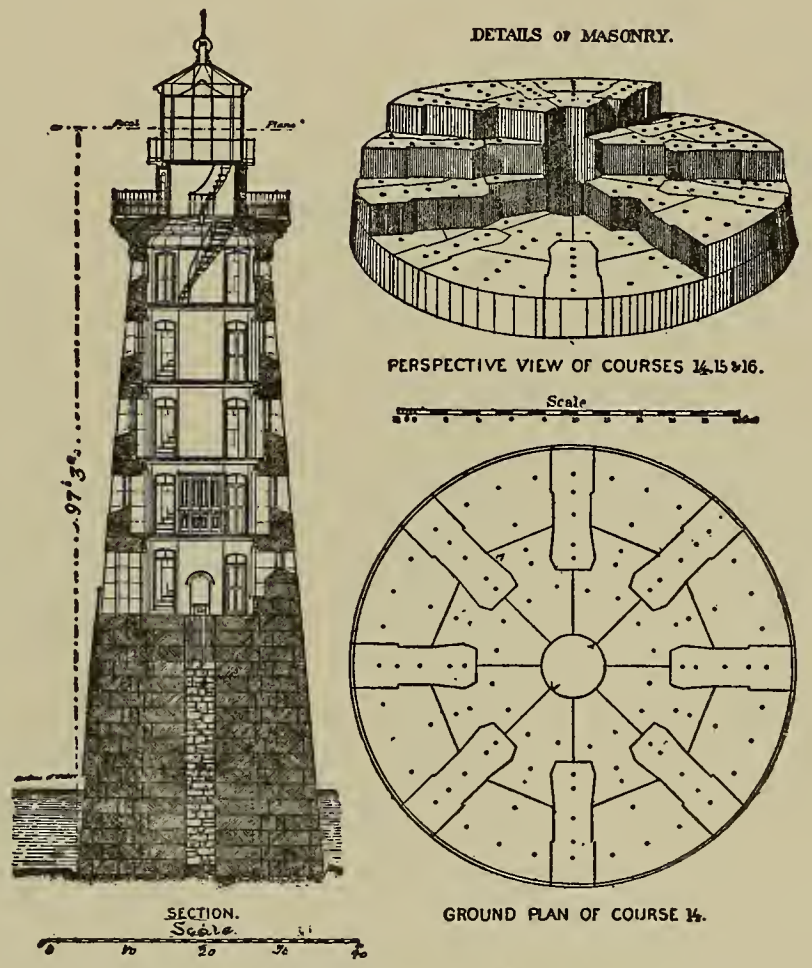
The first landing on the ledge was made in 1855 and the light-house was finished in 1860. The cost of the light-house and of the keepers' houses on shore was $300,000. (Barnard on Light-Houses and Alexander on Minot's Ledge Light-House, T. A. S. C. E., vol. viii.)

Spectacle Reef Light-House, Lake Huron.—This light-house is exposed to the wave-action of Lake Huron and to the pressure of ice-packs, moved by currents which have a velocity of from two to three miles per hour. It is built on a reef in 11′ of water, 10½ miles from the shore.

To build the light, a crib pier, 92′ square and 24′ high, having an interior well 48′ in diameter, was first built and placed, in the manner described for the Stannards Rock light, of which it was the model. Within this pier a cylindrical coffer-dam, 36′ in diameter, was made of jointed staves, 14′ long, 4″ thick, and 6″ wide, bound by three iron hoops, and braced and stayed inside against a centre post. A loose rope of oakum was fastened to its lower edge. This cylinder was built over its site, suspended from the top of the pier, and when finished, was lowered to place and the staves driven home with a maul. A canvas flap and a loosely twisted hay rope, 4″ in diameter, fastened on the outside of the base of the cylinder, assisted in making the joint against the rock water-tight, when forced down by the water-pressure after the interior had been pumped out.

The bed-rock was prepared and the tower was constructed inside this coffer-dam. It is a masonry tower, in shape a frustum o a cone, 32′ in diameter at the base and 18′ in diameter at the spring

Fig. 16.



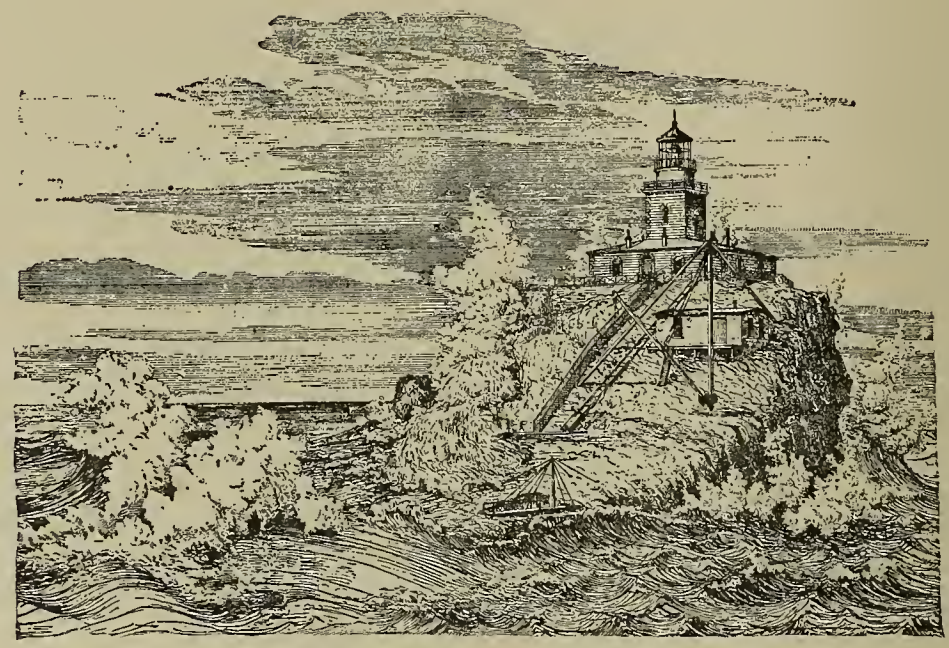
Light-House at Spectacle Reef, Lake Huron.

of the cornice, 80′ above the base. The cornice is 6′ and the parapet is 7′ high. The tower is solid for 34′ above the base, and is composed of blocks, 2′ thick, cut so as to interlock throughout each course, somewhat like those in the Minot's Ledge light. The foundation course is bolted to the rock with $2\frac{1}{2}''$ bolts, 3′ long, which enter the rock 21″. The courses are bolted to each other with $2\frac{1}{2}''$ bolts, 2′ long. All of the bolts are wedged at both ends, and set in Portland cement. The remaining details are shown in Fig. 16. The stones were cut at the depot, 16 miles distant, and were there fitted together, course by course, on a masonry platform.

This light-house was begun in May, 1870, and was finished in 1874, but the available working time was only twenty months. The total cost was $375,000. (Modern Light-House Service.)

Tillamook Rock Light-House, Oregon.—Tillamook Rock is a basaltic rock, which rises abruptly from deep water, one mile off the coast

Fig. 17.



Tillamook Light-House.

of Oregon, twenty miles south of the mouth of the Columbia River. Its top was 121′ above the low-water level, and its faces were precipitous on all sides excepting the north-east. At all times the sea broke violently against it, making a landing dangerous even in calm weather.

Work was started October 21, 1879. Two men were landed on

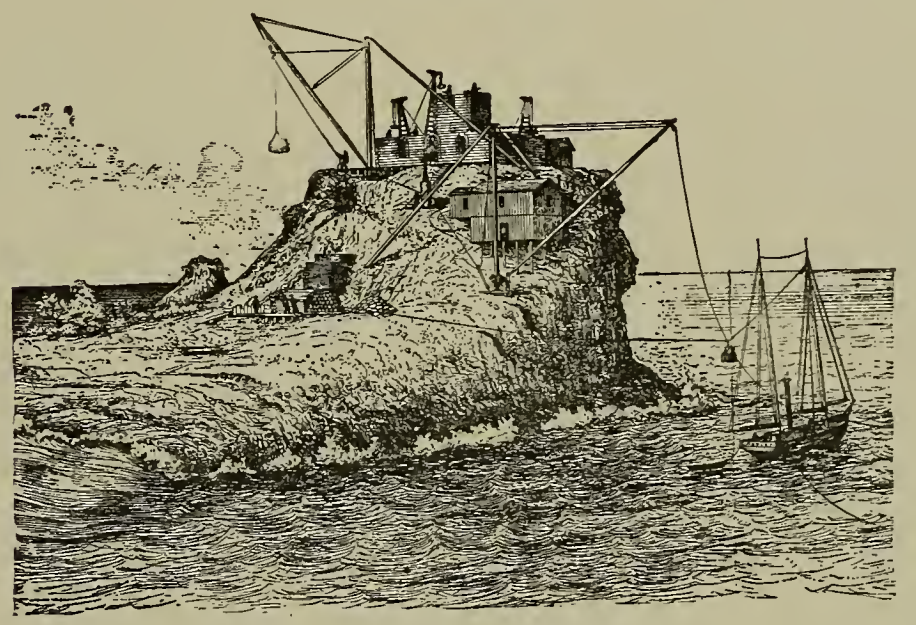
the rock from a small boat. By their aid a line was run from the rock to the supply steamer, which was anchored as close as possible. The remainder of the working party and the supplies were hauled to the rock by a traveller, running on this line. Work was begun at once and prosecuted continuously, excepting when interrupted by storms, at which times the working party was in danger of being swept away by the water which dashed completely over the rock, as well as by the violence of the wind.

The entire top of the rock was cut off to the level 91½′ above low water, by drilling and blasting. The surface had weathered and split into prismatic blocks, but the interior was very tough, so that the drills required resharpening after penetrating 2″. The first ledge was started at the 96′ level by suspending a quarryman in a boatswain's chair from a ring-bolt in the top of the rock, or where the rock was less steep by having each man work with a life-line tied around his body. These men drilled shallow breast-holes, 12″ to 18″ deep, and 1¼″ in diameter. Light charges of black powder, not exceeding a pound each, were used, and a narrow ledge was blasted out, which was gradually enlarged. After a good working face had been made, holes were drilled 15′ to 20′ below the top and breast-holes 10′ to 15′ deep and 2¾″ in diameter, were driven at an angle of about 40 degrees with the horizon. These holes were charged with 12 to 15 lbs. of giant powder No. 2, and firmly tamped with sand. When fired, large seams were opened through the mass. Charges of 100 or more pounds of black powder were exploded in these fissures, frequently bringing down 200 to 250 cu. yds. of rock at a time. The total amount of rock removed was 4730 cu. yds. with a consumption of 1231½ lbs. of black powder and 300 lbs. of giant powder, making an approximate equivalent of one pound of black powder to one cubic yard of rock.

The following is a description of the methods and plant used for landing the materials on the rock and for placing them in the buildings:

A small frame triangular derrick, 20′ high, strengthened by cross cleats at short intervals from the top to the bottom, and fitted with a winch, was first set up on the 90′ level, near the outer face of the rock. By its aid a large derrick was landed and set up on a lower level, about midway between the water and the top of the rock, within reach of the storage platform. This derrick had a 45′ mast and a 75′ boom, and was steadied by a 65′ stiff-leg. A second large boom derrick was placed on the top, to lift the materials from the storage platform to the top. Four ladder derricks, 30′ high, were used for serving stone to the masons. The remaining large plant

Fig. 18.



Tillamook Light-House.

Method of Landing Materials.

included one double-drum hoisting-engine, with boiler, for operating the two large derricks, five water-tight casks for fresh water, three sling-tubs for transferring mortar and small articles, and a small wooden cage, strengthened by iron straps, for landing men. The engine was placed on the 44′ level and worked both derricks. (Fig. 18.)

Materials were landed by the following process: "The boom of

the derrick was first swung outwards towards the vessel, and then the hoisting-rope, after passing successively through the blocks at the foot and top of the mast and at the peak of the boom, was united with the fall of the vessel. The latter fall was further led through a single block hung upon a bridle which connected the masts of the vessel at their top and passed thence to the winch of a donkey-engine on deck. The hoisting-rope carried a hook permanently lashed to it, from which the articles to be transferred were suspended. The stone, singly if heavy, or in pairs if small, or any other article conveniently bundled, was embraced by two rope slings, which were drawn together at the top and attached whilst in the hold of the vessel to the hoisting-hook. It was first raised by the donkey-engine until it had cleared the deck by a few feet, and then the hoisting was taken up and continued by the large engine on the rock, whilst the donkey eased off to keep the article steady. By the time the stone was directly underneath the boom it was high enough to be landed, and the boom was swung around and the stone lowered to the wharf."

"The buoys to which the vessels were moored whilst discharging their cargo consisted of ordinary spars of Oregon spruce 45′ long and 2′ 6″ in diameter at the butt. To make easy attachments with the hawsers, one hole 8″ in diameter was made in the spar 2′ from the top, and another at right angles to the first, 1′ lower down. To the lower end of the spar was fitted a shackle of $1\frac{1}{2}$″ round iron, securely bolted with 1″ bolts, with which was connected a mooring-chain, 40 to 45 fathoms long, with a heavy sinker at the bottom. Three buoys were used: the first on the west side of the anchorage with a semi-spherical sinker weighing 5500 lbs., the second on the east, with two sinkers aggregating 7000 lbs., and the third on the south, with a 5500-lb. sinker. The depth of water in which they were placed was approximately 23 fathoms."

On arriving at the anchorage the vessel was placed with her head to the sea and lines run out to the buoys; bow and stern lines were also carried to the rock and made fast to ring-bolts. All the lines were then manned, and by easing off the buoy-lines and hauling on the bow and stern lines leading to the rock, alternately, the vessel was gradually drawn to within 100′ of the mast of the derrick, as close as it was usually safe to approach the rock. At this distance the hawsers running to the buoys were each 60 fathoms long."

The keeper's dwelling and the light tower are built of fine and compact basalt, of a light-gray color, and having a specific gravity of 2.25. The materials were bought by contract, delivered at a wharf in Astoria. The amounts used and the prices paid were as follows: 5914½ cu. ft. first-class ashlar stone, at $1.60 per cu. ft.; 2880 cu. ft. second-class ashlar stone, at $1.25 per cu. ft.; 96,664 brick, at $12 per M; 2635 cu. ft. sand, at 8 cts. per cu. ft. The ashlar stone was dressed true to dimension. The materials were carried to the rock on a chartered vessel, and the buildings were put up by hired labor.

The dwelling is a stone structure, 48′ × 45′, with an extension for fog-sirens, 32′ × 28½′, under the same roof. The lantern is on a stone tower which rises from the centre of the main building. The foundation is in two courses. The lowest course of stone has a thickness of 2′ 6″. Each stone is bolted to the rock by two $1\frac{1}{4}$″ round iron bolts, 32″ long, and is cramped to its neighbor by a double cramp, $1\frac{1}{2}$″ × ½″ × 12″, let into holes 3″ deep. The second course is 4″ narrower, and has its stones cramped together like those of the first course.

The walls are 2′ thick. They are lined with a brick wall 8″ thick, leaving an intervening air-space of 2″.

Work on the rock was begun Oct. 21, 1879, and by the 8th of January, 1881, the light-house was completed. The light was displayed for the first time Jan. 21, 1881.

The total cost of establishing the light was $123,500. Of this $10,718 was paid for labor in reducing the rock; $30,200 for other labor; and $26,400 for transportation of men and materials.*

Another masonry light-house has lately been constructed on Seal Rock, St. George's Reef, off the north-west coast of California, at a

* For a detailed report on this work see report of Col. Gillespie, in Annual Report of Light-House Board for 1881.

cost of $704,600. This work was similar in character to that at Minot's Ledge and Tillamook Rock, but unlike those works, was greatly delayed and increased in cost by intermittent and insufficient appropriations.

Pile Beacons, Tampa Bay, Florida.—These may be considered fairly typical in construction details of important beacons and day-marks, built in water in which the teredo is found. Each beacon consists of a lantern or a day-mark, mounted on a pole 27′ 3″ high, which stands on a triangular deck 12′ long on a side, 12′ above the water, supported by three piles. Iron guys steady the pole on the platform, and the piles are tied together by iron tie-rods running from the top of each pile to a point on each adjoining pile at about mid depth. The day-marks are either cylindrical or pyramidal in shape, according to the side of the channel, 3′ high and 28″ in diameter, and 3′ 6″ high and 3′ in diameter, at the base, respectively. They consist of a cast-iron skeleton frame, with the surface formed of vertical or horizontal wrought-iron slats.

The piles are of Georgia pine, stripped of the bark, not less than 10″ diameter at the smaller end, and 12″ diameter, at the larger, when cut off, and of a length sufficient to allow the required penetration and the required length above water. The piles are driven until the penetration is at least equal to the horizontal distance between the three piles of the platform from centre to centre, and then until the penetration is less than 1″ under the last blow of a series of five, each blow of which is equivalent to that delivered by a hammer weighing 1500 lbs. falling 10′ upon a solid pile head. The piles must be straight, truly pointed, and ringed, if necessary, in order to secure due penetration without injury to the head. When driven, the piles must stand plumb ; their centres must lie in the corners of equilateral triangles, the length of sides of which varies with the depth of water in which the beacon is built, from 17′ in water 15′ 6″ deep to 12′ in water 5′ 6″ deep.

The tops of the piles are cut off square at low-water mark, and are covered accurately with a cast-iron plate, 12″ in diameter and 1″ thick, fastened to the pile by a spike driven through a hole in its centre. A cast-iron pipe-sleeve is then fitted over each pile, with its top end flush with the top of the bearing-plate, and extending to a depth of two feet below the bottom of the bay. The sleeves are sound, straight castings, with $\frac{7}{8}$″ walls, accurately cored. Each sleeve has a faced flange at the top, and two double, hook-shaped lugs at about mid depth, each pair spaced 60 degrees from centre to centre. These receive the ⊤ heads of the lower ends of the tie-rods.

On these piles, thus protected, cast-iron columns 12′ high with faced flange ends are bolted. These columns are 8″ in outside diameter, have walls $\frac{3}{4}$″ thick, and are straight and accurately cored. The bottom flange is braced by four strengthening ribs, 1′ high. The flange of the top of the column is extended through one third of its circumference to a radius of 10″. Below this extension are two pairs of strengthening ribs 13″ long. These are located accurately over the lugs on the sleeve, and form pockets to receive the head of the tie-rods, which are fastened to them by pins, passing through holes in the ribs and an eye in the head of the rod. The columns and sleeves are bolted together with eight bolts through the flanges. The deck is bolted to the columns by two bolts through each flanged head.

The tie-rods are round iron, $1\frac{1}{4}$″ in diameter, in two parts, united by a turnbuckle. Each has a ⊤ at the lower, and an eye at the upper end. There are two ties for each column.

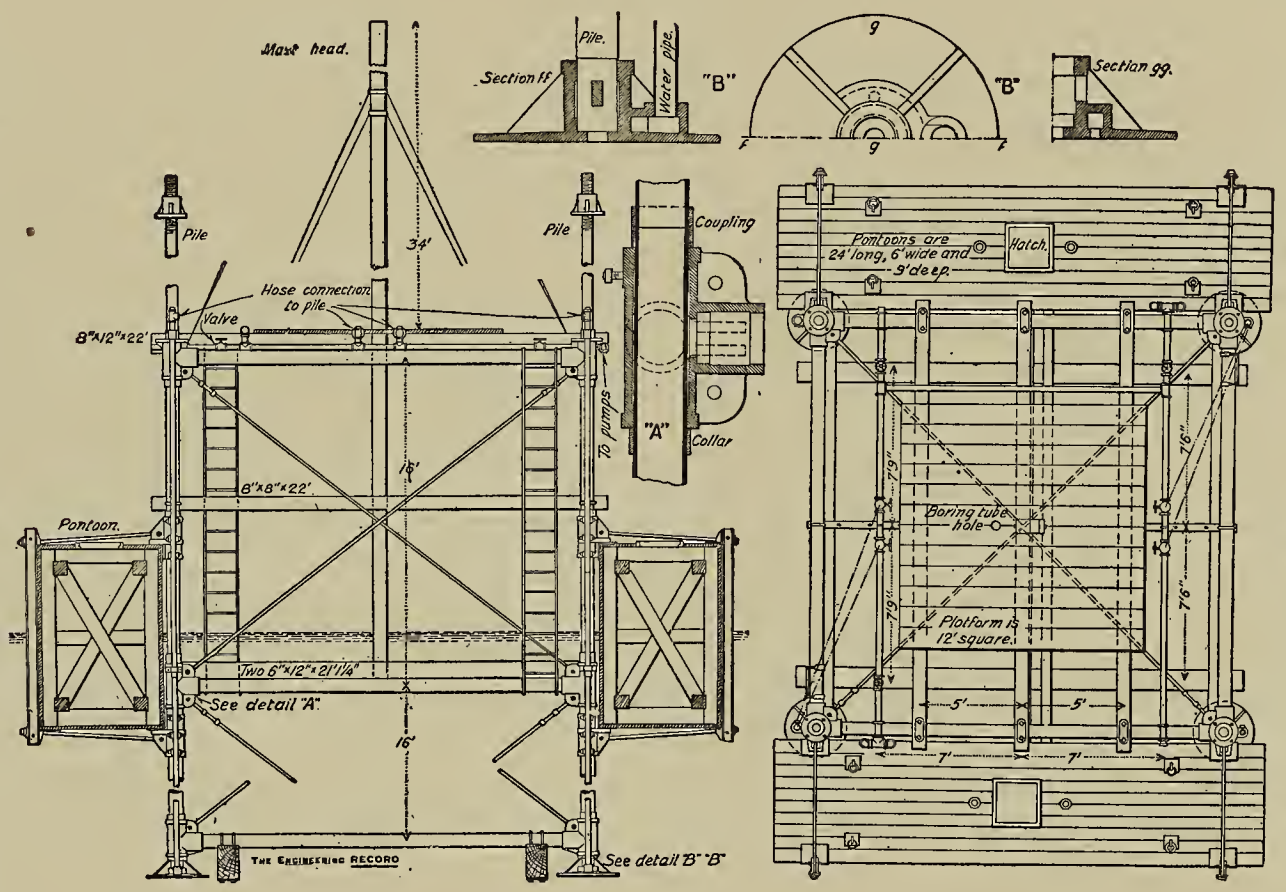
The frame of the deck is a triangle made of three pieces of 8″ × 12″ yellow pine, bolted together and to the heads of the columns at the angles. An 8″ × 12″ piece, gained in 5″ at the ends, is bolted on this frame, from the vertex of one angle to the middle of the opposite side. 2″ × 5″ yellow-pine scantlings are bolted to this piece, with the tops flush with the tops of the sides of the frame, and, with the adjacent side pieces, support a deck of 2″ × 12″ yellow-pine plank, laid with $\frac{1}{2}$″ joints, and spiked to the frame and scantlings.

A cast-iron foot-plate, 10″ × 9″, with a hub $4\frac{1}{2}$″ high, is fastened to the middle piece on the frame, directly over the centre of gravity

of the triangle. This plate bears the lantern-post, the base of which fits accurately over the hub. The lantern-post is made of well-straightened wrought-iron piping, in two sections. The lower section is 5.56″ in inside diameter, and is faced at the lower end and fitted tightly over the hub. Its upper end is reinforced by a steel collar. The upper section is of extra-strong pipe, 4″ in outside diameter. Its lower end is reinforced with a steel collar, which fits closely in the lower section into which the upper section extends 2′ $4\frac{3}{4}$″. At this distance from the end the upper section carries another collar, with a shoulder which bears on the top of the lower pipe. The joint thus formed between the sections is locked by set-screws. Three iron tie-rods with turnbuckles run from the collar of the lower section to the angles of the frame. On top of the lantern-post is the day-mark, or in a lighted beacon, a casting having a braced arm, 13″ long, with two pulley-wheels on top, enclosed in a casing. The lantern runs up and down on two guide-ropes, fastened to the deck and to the arm. It is suspended from a steel-wire rope, which passes from the top of the lantern up through a hole in the arm, over the pulley-wheels on top, and down through the interior of the post to a drum, enveloped in a casing and fixed to the post near its base. Access to the deck is had by an iron ladder fastened to one of the piles.

Seven aids to navigation of this kind were built in Tampa Bay at a total cost of $7600. The metal-work was furnished under one contract and the woodwork and labor for erecting the beacons under another.

FIG. 19.



Platform for Test-borings, Outer Diamond Shoals, Cape Hatteras. — Early in 1894 the Light-House Board constructed a platform on these shoals, for the purpose of making test-borings. The following description of the platform and of the methods employed for placing it is reprinted, by permission, from the *Engineering Record* of June 16, 1894:

"It was essentially a skeleton framework supported on disk-piles fitted with connections for sinking a tube-well, just as is done for purposes of water-supply.

"The framework employed was in the form of a square skeleton prism measuring 20′ on a side and 32′ high. The columns at each

In other cases piles for beacons and marks are protected by an iron pipe-sleeve, extending from above high-water mark to some distance into the bed of the sea, with Portland-cement grout filled in between the pile and its envelope.

corner were made of wrought-iron tubing $7\frac{5}{8}''$ in outside diameter and half an inch thick. They were provided with shrunk collars, firmly secured in place by steel studs, which formed seats for the castings by which the ties and horizontal struts were attached, the detail drawing 'A' of one of the middle connections showing the method of assembling the parts. The 12 horizontal struts were made of tubing of the same size as the columns and of the same thickness. The diagonal ties were $1\frac{1}{2}''$ round irons, with turnbuckles of the usual form. Inside each of the vertical columns was a pile made of two pieces of 6″ rolled iron, welded together after their ends had been prepared to receive the disk, clamps, and nuts. The lower ends of the piles were turned to fit the disk-shoes, to which they were attached by steel keys. Each pile was also provided with a jet-pipe composed of two lengths of 3″ wrought-iron piping and fitted at the lower end into the tapped boss of the disk. The construction of the disks is fully shown in the detail drawings 'B,' 'B.'

"The two pontoons used in floating the framework were 24′ long, 6′ wide, and 9′ deep. Their framework was made of yellow-pine timbers, and the sheathing was of 2″ and $2\frac{1}{2}''$ white-pine planking fastened by galvanized-iron spikes. A 6″ stop-valve in each pontoon enabled water to be admitted whenever desired, and a 3″ pipe was provided for pumping out the water which might leak in.

"The boring was done by means of three branches of pipes of different diameters, which were driven by a water-jet into the shoal. The largest branch was 5″ in diameter, 62′ long, and weighed 930 lbs.; the second was $3\frac{1}{2}''$ in diameter, $102\frac{1}{2}'$ long, and weighed 940 lbs.; the third was 140′ long, 2″ in diameter, and weighed 550 lbs. The branches were hung from the masthead by a tackle and sunk through a hole in the platform, shown in the accompanying plan. A string of boring-tools was carried along to be used in case hard material was encountered, but they were not needed.

"The following account of the manner in which these appliances are assembled and used is slightly condensed from the report prepared by Mr. J. E. Rettig, Superintendent of Construction of the Board:

"The framework and boring apparatus by means of which the work has been accomplished were designed by the Board in September, 1893. The materials, which were furnished under two different contracts, were delivered during April, 1894, at the Lazaretto Light-House Depot, Baltimore, where it had been contemplated to erect the apparatus and transfer it to the water. However, as it was learned upon inquiry that suitable shears and other necessary conditions for launching the structure could only be secured at the Newport News Shipbuilding and Dry Dock Company, Virginia, the carpenter-work only, comprising the fitting of the timbers to the framework, was performed at Lazaretto Depot, when, after the completion of the same, the materials and also the two pontoons were loaded on a barge, which measured $23\frac{1}{2}' \times 70'$ on the water-line, and which had a displacement of 72 tons due to its own weight. The loaded barge left Baltimore on May 10; it arrived at Newport News at noon May 11, when the erection of the apparatus upon the deck of the barge by means of a very suitable derrick of 12 tons lifting capacity was commenced.

"The different parts of the ironwork had been well constructed and fitted, and not the slightest delay, so often due to defective workmanship, occurred; and on May 17 the complete apparatus, with pontoons connected in their places, weighing 46 tons, was lifted off the barge and successfully transferred to the water by means of the 100-ton shears at the shipyard. Mr. Rettig states that the undertaking so far came out successfully and in accordance with the various calculations made for determining the stability of the loaded barge, which were doubted by nearly everyone. Knowing, however, that with the structure completely erected on the barge the metacentre of the floating mass was 8′ 6″ above the centre of gravity of the same, and that it would have required a maximum moment of 206 foot-tons to upset the barge, he determined to proceed in the way it had always been contemplated, and complete success crowned the result. After launching, the mast, surmounting the framework, was put in place; all necessary water-pipes and rubber hose, as shown on the drawings,

were placed in position; the pontoons were well secured to the structure by four $1\frac{1}{4}''$ tie-rods, and on May 19 the apparatus was ready for sea, drawing 21′ of water and having a metacentric height of 6′ 8″, which proved, on the way to the site, to give ample stability to the floating mass.

"On Monday morning, May 21, Mr. Rettig took his quarters on the 'I. D. Jones,' the Merritt's Wrecking Organization's steamer, to wait for suitable weather. On Wednesday morning, May 23, he telegraphed the New York office of the Wrecking Organization to have their steamer report at Newport News as soon as practicable, and at 12 o'clock, noon, the steamer was made fast to the wharf at the shipyard close to the apparatus, where it required but a short time to drill the intelligent crew of the vessel for the work to be performed at the site. At 1 P.M. on Wednesday, May 23, the $7\frac{1}{2}''$ tow-line, connected to the structure by a long rope bridle, took up its slack, and they left port with a speed of from 3 to $3\frac{1}{2}$ miles per hour. Nothing unusual occurred on the journey, the apparatus floated and towed like a well-designed vessel, and had it not been for the leakage of the pontoon on the port side of the structure, which made water at the rate of $\frac{3}{4}$ cu. ft. per hour, and which was pumped at sea every 12 hours, the apparatus required no special attention. In leaving the capes a heavy swell from an easterly direction, caused by the storm on May 21, was met, but as it had little effect upon the structure no further notice was taken of it.

"On Friday morning, May 25, they arrived at Cape Hatteras. Mr. Rettig located the position of the steamer and then proceeded on a new course towards the buoys on the outer shoals, which came in sight at 1 P.M. The tide and the sea were not suitable at the time for grounding the structure, and that day was spent taking soundings on a line from deep water to the buoys in range of the main light at Hatteras. Finding that the soundings were exactly as indicated in a letter from Lieutenant-Commander Garrett, U. S. N., they anchored at a distance of about 2 miles from the buoys on the east side of the shoals, where they remained, not having the least anxiety about bad weather, until Sunday morning at 7 o'clock, when all indications and conditions of the weather were such that the grounding of the apparatus could be attempted. High tide occurred at the shoals at 11.30 A.M.; at 7 A.M. everything was ready for work; the anchors for mooring the steamer alongside the structure after it had been grounded were ready to let go at a moment's notice; the vessel slowly approached the final resting-place of the apparatus; at 11 A.M. the men were stationed on the structure, and at 11.30, when a moderate swell and only a choppy sea, but a strong current, prevailed, the apparatus struck bottom, the valves in the pontoons were opened, and within 15 minutes the pontoons, which had carried the structure, were liberated and floated off in a southeast direction, impelled by a current too strong to enable them to be saved without the sacrifice of much valuable time. While all this was going on the steamer's crew unfastened the tow-line and placed the moorings at the corners of a square having a circumscribed circle from 600′ to 700′ in diameter with the structure at its centre, and at 1 P.M. the vessel was securely moored alongside the framework and ready to furnish water under pressure through two $2\frac{1}{2}''$ hose for driving the four piles by which the structure was to be secured to the bottom. The first pile was sunk to the contemplated depth of 13′ into the sand and secured to the structure within 10 minutes; the second pile went like the first; the third was bearing upon the sand, and as the water would not discharge from the openings of the lower disk it required underwashing by a 2″ pipe to start circulation, and when this took place the third pile went successfully into its place. The fourth pile started all right, but in its fall broke the T of the pipe which conducted the water to the disk. The T was replaced by another; the disk, around which the sand had settled, was underwashed like that of the third pile, and the pile went down like the others; and at 2 P.M. the structure was secured and stood firm on the dreaded shoal.

"The 5″ pipe through which borings were to be obtained was then screwed together and washed into the sand to a depth of 40′ below the surface of the shoal, and when this was accomplished a

squall from the south-west stopped the work. At 4 P.M. the steamer's moorings were unfastened, and soon after the vessel returned to its old anchorage. During the night the weather became settled again. The steamer went under way at 5.30 A.M.; it was moored alongside the beacon again at 7 A.M., when within three hours the $3\frac{1}{2}''$ and $2''$ pipes were sunk as contemplated, and the borings to a depth of 105′ below the surface of the shoal were secured. The water for washing the piles and pipes was furnished by the steamer's wrecking-pump under a pressure of 120 lbs. per. sq. in., but this pressure had to be reduced when the $3\frac{1}{2}''$ and $2''$ pipes were nearly sunk to their required depths, for the friction of the water and sand on the outer surfaces of the pipe was so great that it stopped the descent of the pipes by their own weights. The borings which were brought up in the annular space between the pipes were caught in a canvas bag above the surface of the sea, and consisted mainly of fine alluvial sand. The sand of the surface of the shoal is light in color; the sand which came from a depth of between 40′ and 80′ below the surface of the shoal is light gray in color, and clean. The sample which came from a depth of between 80′ and 105′ below the surface of the bottom is dark gray in color, very fine, and mixed with small shells and black mud. The structure was then cleared of all unnecessary planks and timbers; the moorings of the vessel were taken up, and at 11 A.M. on Monday, May 28, the party left for Norfolk, Va., where they arrived at 3 A.M. on May 29, without having had a single accident during the undertaking."

CHAPTER V.

TREASURY DEPARTMENT, OFFICE SUPERVISING ARCHITECT: LAWS AND REGULATIONS.

Organization of Office.—The construction of the public buildings under the Treasury Department is in the charge of the Supervising Architect of the Treasury, whose position as well as that of his assistant is provided for in Sec. 235, R. S. The duties of the Supervising Architect comprise the preparation of all plans and estimates for public buildings, the acquisition of land for their sites, and the supervision of their construction, repair, and custody. By the Act of February 20, 1893, the Secretary of the Treasury is authorized, in his discretion, to obtain plans, drawings, and specifications for the erection of the public buildings, and the local supervision of the construction thereof, by competition among architects under such conditions as he may prescribe. In such case the general supervision of the work is to continue in the office of the Supervising Architect of the Treasury Department, whose duties, with the exception of the work specified, remain the same as in other cases. The Secretary of the Treasury is authorized to employ as many skilled assistants for the Supervising Architect as may be necessary, to be paid from the appropriation for the various public buildings.

The following recent order describes the division of duties in this office as at present organized :

"The office of the Supervising Architect of the Treasury Department is reorganized in the following manner, and its business will be conducted in accordance with this order, subject to such changes and additional regulations as the Secretary of the Treasury may hereafter make :

"In the office of the Supervising Architect of the Treasury Department there shall be a supervising architect, whose duties shall be those which are now or may hereafter be prescribed by law and the orders of the Secretary. To the Supervising Architect six divisions are assigned, as herein below set forth, the architectural and technical work of which, together with the discipline of the force employed in such work, shall be entirely under his direction and control, subject to such orders and regulations as may be made by the Secretary of the Treasury. The divisions assigned to the Supervising Architect and the work to be performed in each are as follows :

"1. The engineering and draughting division, the chief of which shall be known as the chief constructor. In this division will be prepared designs and working drawings for public buildings, which are not opened to competition under the present or future legislation, and the draughting work required by the repairs division.

"2. The tracing division, which will trace the working drawings for photographic duplication.

"3. The photograph gallery, which will make photographic duplications of the plans aforesaid.

"4. The computing division, which will prepare estimates of cost for public buildings, specifications for the same, and will pass, under instructions from the Supervising Architect, upon all questions of material submitted for work under contract, and carry on all work similar in character to that now performed in this division.

"5. The repairs division, which is charged with the repair and preservation of all public buildings under the control of the Treasury Department, the heating, hoisting, and ventilating apparatus in said buildings, and the purchase of vaults, safes, and locks.

"6. The inspection and material division, which will have charge of the office corps of inspectors, writing their letters of instruction and receiving their reports. This division is also charged with

the active inspection and supervision of all work provided for or prosecuted under any contracts, drawings, or specifications prepared in the office of the Supervising Architect. It will be the duty of the chief of this division to receive all material-men who visit the office for the purpose of securing the use of their goods in public buildings, and he will take the data necessary to enable him to present intelligently the merits of any article which, in his opinion, should be brought to the notice of the Supervising Architect.

"The Supervising Architect will keep his office either in the engineering or draughting division, or in direct connection therewith, and will not be required to receive visitors except those who desire information with reference to matters of construction pertaining to work in actual progress. He will sign the mail which originates in his divisions or which arises from the necessities of the public service in connection therewith; but all mail heretofore signed by the Secretary of the Treasury, or an assistant secretary of the Treasury, will continue to be so signed.

"All business of an executive or administrative nature not within the jurisdiction and control of the Supervising Architect will be conducted by a chief executive officer, who will act as supervising architect in the absence of that official, and whose duties, in general terms, shall be as follows:

"The chief executive officer will receive all visitors on public business, except material-men and those who may desire to confer with the Supervising Architect concerning matters of an architectural and technical nature pertaining to the work of construction in actual progress, and he will receive and have distributed to the proper divisions all mail matter addressed to the Supervising Architect or other officials in the office, and check all letters and other papers originating in the divisions of the Supervising Architect as to proper official form.

"He is charged also with all questions of discipline arising in the divisions assigned to him, and all messengers and mailing-clerks will be directly under his control; all correspondence of the office not originating in the office of the Supervising Architect, or in the divisions assigned to him, and which does not require the signatures of the Secretary or an assistant secretary, will be signed by the Chief Executive officer, such as transmission of checks payable out of the annual office appropriations for the repair and preservation of public buildings, heating, hoisting, and ventilating apparatus and vaults, safes, and locks; all the correspondence with the disbursing agents, superintendents, and others, concerning requests for funds and notifications that moneys have been asked for and will be transmitted; all questions relating to matters of final payment, and generally all other correspondence which does not arise in the work performed by the six divisions strictly under the control of the Supervising Architect. He will also be the custodian of the bids and open them, in conjunction with the Supervising Architect and chief computer. Under his immediate supervision and control there shall be two divisions, as follows:

"1. The law and records division, the chief of which will be the law officer of the entire office, and his opinion upon matters of law originating therein shall be binding, subject to the right of reference, through the assistant secretary of the Treasury in charge, to the Secretary of the Treasury, or the law officers of the Department. This division will begin and carry forward the work of putting into permanent record form all deeds and other papers relating to titles for sites of public buildings, marine hospitals, quarantine stations, and all other real estate belonging to, or hereafter acquired by, the United States and under the control of the Secretary of the Treasury.

"2. The division of accounts, which will keep a complete system of books, showing all appropriations made by Congress for the purchase of sites and construction of public buildings to be erected by the Secretary of the Treasury; the annual office appropriations, and the charges against each and every appropriation. This division will also prepare all the correspondence with disbursing officers, together with all other correspondence relating to payments out of the various appropriations made by Congress.

"A Board of Award, for the awarding of contracts in the office of the Supervising Architect, is hereby created, consisting of the Supervising Architect, the chief executive officer, and the assistant secretary of the Treasury in charge. This Board will prepare recommendations to the Secretary of the Treasury for the award of all contracts arising in the office for the construction of public buildings and repairs to the same, and all contracts for repairs to heating, hoisting, and ventilating apparatus and the purchase of vaults, safes, and locks. A majority of the Board must concur before any recommendation is sent to the Secretary of the Treasury, and in case any member of the Board shall dissent, the majority and minority shall each file a brief statement in writing setting forth the reasons for concurrence and non-concurrence.

"The copying division and the division of records and files are abolished. The work now performed by the copyist division is indefinitely suspended, and the force now employed in the above-named divisions is transferred to the law and record divisions.

"This order shall take effect on the 1st day of January, 1895.

"J. G. CARLISLE, *Secretary.*"

Purchase of Land for Site for Public Building.—"In the selection of any site for any public building not yet commenced, reference shall be had to the interest and convenience of the public, as well as to the best interests of the Government; and the Secretary of the Treasury shall have power, and it shall be his duty, to set aside any selection which in his opinion has not been made solely with reference thereto.

"No expenditure shall be made upon any building, a site for which has been selected, and work upon which has not been commenced, until such of the persons who acted as commissioners in selecting such site shall make and file with the Secretary of the Treasury an oath or affirmation that he is not, at the time of making the affidavit, and was not at the date of making the selection of such site, directly or indirectly interested in the property selected for the same, and a similar affidavit shall be made and filed by each and every person hereafter appointed as such commissioner, before any site shall be finally adopted. In either case a failure on the part of any commissioner to make and file such an affidavit shall render the selection void." (Act June 23, 1874.)

Expenditures on Public Buildings.—"And hereafter no money shall be paid nor contracts made for payment for any site for a public building in excess of the amount specially appropriated therefor; and no money shall be expended upon any public building on which work has not yet been actually begun, until after drawings and specifications, together with detailed estimates of the cost thereof, shall have been made by the Supervising Architect of the Treasury Department,* and said plans and estimates shall have been approved by the Secretary of the Treasury, Secretary of the Interior, and the Paymaster-General; and all Appropriations made for the construction of such buildings shall be expended within the limitations of the Act authorizing the same or limiting the cost thereof; and no change of said plan involving an increase of expense exceeding ten per centum of the amount to which said building was limited shall be allowed or paid by any officer of the Government without the special authority of Congress." (Act March 3, 1875.)

"That no Act passed authorizing the Secretary of the Treasury to purchase a site and erect a public building thereon shall be held or construed to appropriate money unless the Act in express language makes such appropriations." (Act August 7, 1882.)

". . . The Secretary of the Treasury is authorized to acquire, by private purchase or by condemnation, the necessary lands for public buildings and light-houses to be constructed, and for which money is appropriated, . . .; and there may be expended by the Secretary of the Treasury, from the several amounts appropriated for the construction of public buildings, the expenses incident to the procuring of sites for said buildings respectively." (Act March 3, 1883.)

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* Modified by Act of February 20, 1893. See p. 136.

The Act of August 1, 1888, describes the methods to be followed in acquiring real estate by condemnation. (See p. 2.)

The Act of March 2, 1889, forbids the Secretary of the Treasury to approve the plan of any public building, the erection of which has been authorized by Congress, until the site has been finally selected; he is further forbidden to approve of any plan for any such building which involves a greater expenditure for the completion of the building, including all heating apparatus, elevators, and approaches, than the amount remaining from the sum specified in the law after deducting the cost of the site.

The Act further provides that all legal services connected with the procurement of titles to site for public buildings, other than for life-saving stations and for pier-head lights, shall be rendered by United States district attorneys. It is further made the duty of the Attorney-General to require the grantors in each case to furnish to the United States, free of all expenses to the Government, all requisite abstracts, official certificates, and evidences of title that he may deem necessary.

BUSINESS METHODS.

Chapter I gives the general laws and regulations governing the care and disbursement of public funds. The laws relating to disbursements are on page 1; to labor, page 1; for protection of persons furnishing materials or labor for use on public works, page 1; to purchase of land, page 2; to legal holidays, page 2; to purchases and contracts, page 2; to payments, page 5; to method of obtaining duplicate of lost check, page 7; to form of check, page 8; to payments to corporations, page 9.

Appropriations.—In general, it may be stated that there are five (5) classes of appropriations under the control of this bureau, i.e., what is known as a construction appropriation, available immediately upon the approval of the act containing it (there being one for each designated building to be erected or to be repaired under a special appropriation, and which has no limitation as to time), and four (4) appropriations under the limitation of the fiscal years, and for the current fiscal year. They will be found in the "Digest of Appropriations" on pages 44, 45, and 74, as follows:

"Repairs and Preservation of Public Buildings." This is for repair and preservation of Custom-houses, Court-houses, Post-offices, Marine Hospitals, Quarantine Stations, and other public buildings under the control of this Department.

"Heating Apparatus for Public Buildings." For heating, hoisting, and ventilating apparatus, and repairs to the same, for all public buildings under the control of the Treasury Department, including Marine Hospitals and Quarantine Stations.

"Vaults, Safes, and Locks for Public Buildings." For vaults, safes, and locks, and repairs to same, for all public buildings under the control of the Treasury Department.

"Plans for Public Buildings." For books, photographic materials, and use in duplicating plans required for public buildings.

In connection with appropriations for the construction of public buildings, Congress, with the approval of the President of the United States, the language being similar in nearly all cases, legislates "that the Secretary of the Treasury be and he is hereby authorized and directed to purchase, acquire by condemnation, and otherwise provide a site and cause to be erected thereon a substantial and commodious building, etc., etc." This act must limit the cost of site and building. The appropriations may be made either under this act, or through the Appropriations Committee at a later date, either in one amount or in smaller sums at intervals until the aggregate amount is reached.

A general statute requires that the limit placed by Congress, unless otherwise stated, is to embrace the cost of site, building, heating, elevators, if required, and approaches. (Sec. 3663, R. S.)

Expenditures.—No money must be expended until title to the site is vested in the Government. The mode of selecting the site is within the discretion of the Secretary of the Treasury, and excepting where specially controlled by legislation indicating what land must be taken, it has been the custom of the Department to adopt a method

as follows: First, to invite proposals by public advertisement, stating the area required, location, etc.; the proposals when opened are then reported upon to the Secretary of the Treasury, with recommendation as to the selection which should be made, either by an appointed commission made up of non-Federal officers or by an agent of this Department. After the details in this connection have been completed, if there is no general State act covering such matter, the State is requested to cede jurisdiction over the land, and upon this action being taken by the State legislature, the payment is made, and the property vested in the Federal Government.

When all transactions in regard to the selection of site are completed and purchase-money paid, then sketch plans and estimates are prepared, and submitted, as required by law, for approval by the Hon. Secretary of the Treasury, Hon. Secretary of the Interior, and the Hon. Postmaster-General, (Sec. 3734, R. S., and Act Mar. 3, 1875.)

Office Methods.—Upon this approval being given, the working drawings, amplified by full-sized details and specifications, are prepared either for the entire building, or subdivided in accordance with what is deemed most expedient, under the limit fixed by the appropriation made. As it must be clearly understood that while the limit of cost of the building is a stated amount, the appropriations are often made at intervals, and an amount smaller than the larger sum indicated by the limit is available at any one time, and no liability must be incurred in excess of money available, under the law, excepting in connection with the erection of the Post-office building in the city of Washington, which provides that contracts may be entered into to an amount not exceeding the limit and not circumscribed by appropriations.

Proposals and Contracts.—At this point the method adopted is that which obtains in private enterprises. Proposals (based upon the specifications and drawings, which can be seen at designated points) are invited by public advertisement in local papers and in several technical journals, the bids to be opened at a designated time and to be accompanied by a certified check, payable to the order of the Treasurer of the United States, in an amount sufficient to indicate the commercial standing of the bidders, and also to guarantee the entering into of a contract in the event of the proposal being accepted. (Usually 2% of the total consideration of the proposal.)

Upon the approval of the contract the check is returned, the checks of the unsuccessful bidders having been returned after the award was made.

Formal contracts are required in amounts involving an expenditure of $5000 and over, and simple bonds, on the official form (see Chap. VIII), in sums contemplating from $2000 to $5000. In less than $2000 it is usual to retain a certified check in amount approximately 25 per cent of the bid. The penalty bond on the contract is usually 40 per cent of the amount involved.

It may be stated that special items of work, such as heating and hoisting systems, are generally the subject of separate invitation and contract.

After giving consideration to the various bids before this office a conclusion is reached, and they are all submitted with a synopsis to the Hon. Secretary of the Treasury, with the recommendation for acceptance. Upon the approval being signified, a letter of acceptance is written to the successful bidder accepting the proposal and stipulating the time within which the work shall be completed, and intimating that time consumed in the execution of the contract will not affect the time for completion stated in the letter.

A contract is then prepared upon a regular form (see forms), and having attached the "General Instructions and Conditions," and is supplemented by copies of the proposal, letter of acceptance, specifications, and drawings referred to.

This office is represented at the building by a Superintendent of Construction, under bond, competent to exact a strict compliance with the terms of the agreement, and officers with the title "Inspector of Public Buildings," technically qualified, are detailed from time to time to make an examination for the information of this office as to whether satisfactory progress of work is being made and suitable materials and workmanship are being supplied.

The contract, as reference to the "General Instructions and Conditions" will show, provides for payment at stated times of the full value of work supplied in place complete, less 10 per cent retained for reasons which are apparent.

There is remitted to the Disbursing Agent, who is under bond and located in the city where the building is being erected, an amount sufficient to enable him to make payment of the monthly expenditures, which payments are made upon the certificate of the Superintendent of Construction. When work is completed the Superintendent of Construction must certify that fact to this office, accompanied by a statement of the account, and reciting any circumstances which may have prevented the completion of the work within the stipulated time, in order that all matters may be laid before the Hon. Secretary of the Treasury in connection with inflicting or waiving the penalty forfeiture for failure to complete as agreed. At this point it is the custom of the office to detail an Inspector of Public Buildings to gather all facts, not for the purpose of relieving the Superintendent of his responsibility, but in order that the office may be in possession of all information relating to the matter.

This in brief is the history of any building under construction, and the same applies to all other buildings of like character under this office.

Payments.—Each month the Superintendent of Construction must submit what is known as "Estimate of Funds" upon which is based the remittance to the Disbursing Agent; twice each month, at the 15th and last day, he transmits a brief letter of advice showing the point of advancement reached, and intimating whether the contractor is making a sufficient delivery of materials and employing a force adequate to secure the completion of the work within the contract time. On the last day of each month he forwards what is known as a "Monthly Report" enumerating the various vouchers certified by him during the month, the total amount certified to date, what branches of work are complete, the value of the various branches of work being executed, the amount expended for what is known as machinery (being office furniture, etc.), the amount for contingencies, including the Superintendent's expenses, office fuel, ice, foreman, clerk and watchman, if allowed, and an inventory of all machinery on hand.

It may be noted that custom has made the rule that work on public buildings shall be done under contract, after due competition, but there is no mandatory enactment which bars the Department from purchasing the material and employing labor by the day, except possibly in the case of the post-office in the city of Washington, in which it may be noted that it is provided that contracts may be made up to the full limit of cost, by implication indicating that the work must be done under contract.

Repair Work.—Work under the appropriation for "Repairs and Preservation of Public Buildings" is of the character indicated by the act, being for the repair and preservation of buildings which are completed and occupied. The custodian (or caretaker in charge) of any designated building, who is appointed by the Hon. Secretary of the Treasury, makes representation to the Department that certain repairs are necessary. If of considerable amount, it is usual to instruct an Inspector of Public Buildings to make an examination, and in cases prepare drawings and specifications as a basis for the invitation of proposals for the work, at which point the method of securing bids is similar to that adopted in the construction of public buildings. If of a minor character the custodian is requested to submit an estimate, or alternatively, to submit proposals for the work, competitive in nearly all cases. The Assistant Secretary of the Treasury then grants or declines the authority to make such expenditure. Upon completion of the work vouchers are forwarded to this office and are paid at this Department by the disbursing clerk, charged against the appropriation named.

"Heating Apparatus for Public Buildings" contemplates the repairs of all the heating, hoisting, and ventilating systems in completed and occupied buildings, or modifications to same, and the supply of new heating, hoisting, and ventilating apparatus in occupied

and completed buildings, and the same action is adopted as that indicated under the appropriation for "Repairs and Preservation of Public Buildings."

"Vaults, Safes, and Locks for Public Buildings." As the title indicates, this appropriation is chargeable with all the expenditures in connection with vaults, safes, and locks for completed and occupied buildings, and in addition is chargeable with any expense on account of lock-boxes [post-office] for new buildings, and the action taken thereunder is in character similar to that in the last two preceding statements.

"Plans for Public Buildings." As indicated by the act, this appropriation is available for books, photographic materials, and for use in the photographic duplication of plans required for all public buildings under the control of this Department. From this appropriation is paid all liabilities for technical journals, and architectural and building reference-books, and in the purchase of photographic materials in making sun-prints of drawings to be sent to the various prospective bidders.

INSTRUCTIONS FOR BIDDERS.

General Instructions and Conditions.*—"Blank Form.—Each bidder must obtain a blank form of proposal and prepare and submit his proposal thereon.

"The original drawings named in the specification will be retained on the files of the office of the Supervising Architect, and tracings or photographic copies of the same will be prepared for the use of bidders.

"Return of Drawings.—Parties obtaining copies of the drawings must return them within days from the date of receipt.

"Requirements.—Proposals received from parties who are not known to be regularly and practically engaged in the class of work called for by the drawings and specification, and to possess ample facilities for doing the same, will not be considered.

"Before submitting a proposal, each bidder should make careful examination of the drawings and specification, and fully inform himself as to quality of materials and character of workmanship required, and make a careful examination of the place where the materials are to be delivered and the work performed; and should his proposal be accepted, he will be responsible for any and every error in his proposal resulting from his failure to do so.

"Amount of Bid and Time to Complete.—Each bidder must state in his proposal (in writing and in figures, without interlineations, alterations, or erasures) the sum of money for which he will supply the materials and perform the work required by the drawings and specification, and state the number of days in which he will complete the work from date of letter of acceptance of proposal, should his proposal be accepted; and must sign his proposal with his full name, and give his address.

"In case where a firm, or corporation, submits a proposal, the proposal must be signed with the full name of each member of the firm, or the full name of each officer of the corporation, in addition to the firm or corporation signature, with official corporate seal thereto, and their addresses must be given.

"Forfeiture for Delay.—Each bidder must understand that, should his proposal be accepted, he is to forfeit to the Supervising Architect, acting for and in behalf of the United States, the sum of dollars ( ), as liquidated damages, for each and every day's delay not caused by the Government that may occur beyond the time stipulated in his proposal for the supply of all the materials and the performance and completion of the work; subject, however, to the discretion of the Secretary of the Treasury; and that he is to be entitled to one day, in addition to said stipulated time, for each and every day's delay that may be caused by the Government.

"Samples and Proposals.—Each bidder must submit with his proposal, at his expense, samples of the materials which he proposes to use; the samples to have the name of the bidder, the title and location of the building, and date of proposal plainly marked thereon.

* These "General Instructions and Conditions" are attached to and form a part of, proposals, specifications, and contracts.

(Each sample of stone must be six inches by six inches by six inches, one face showing natural fracture and the other faces showing different styles of finish, with the name and location of its quarry distinctly marked upon it.)

"Each proposal, and the samples of materials, must be delivered at this office prior to the time named in the advertisement for opening the proposals, and those received after such time will not be considered. The samples submitted with the proposal of the successful bidder will be retained; and when required, he must, at his expense, furnish duplicates of the samples.

"QUALITY AND TIME TO COMPLETE.—Each bidder must understand that the quality of the materials proposed to be used, and the time stated for the supply of the materials and completion of the work, will be considered in the matter of acceptance of proposal.

"MEASUREMENTS.—The successful bidder, at the proper time, to be determined by him, must make all measurements necessary for the proper prosecution of the work called for by the drawings and specification; and, during the prosecution of the work, he must make all necessary measurements to prevent misfitting in said work; and he will be responsible therefor.

"BUILDING REGULATIONS.—The successful bidder must fully comply with all municipal building ordinances and regulations, and obtain all required licenses and permits, and pay all charges and expenses connected therewith, and be responsible for all damage to person or property which may occur in connection with the prosecution of the work.

"ALTERATIONS AND ADDITIONS.—The successful bidder must understand that it is a reserved right and privilege of the Supervising Architect to make any additions to, omissions from, changes or alterations in, the materials and work called for by the drawings and specification, and contemplated by and embraced in his proposal; and that any addition to, or omission from, said materials and work are to be made on the basis of the contract unit of value of the materials and work referred to; and that any change in the quality of materials or alterations in work are to be made on the basis of market rates prevailing at the time that such changes or alterations may be desired, and that no claim for compensation for any extra materials or work is to be made, or allowed, without the same being first agreed upon and specifically authorized in writing by the Supervising Architect, under the approval of the Secretary of the Treasury.

"SKILLED LABOR.—The successful bidder is to employ only skilled and reliable workmen in the performance of the work, and must accord to the Supervising Architect the right to decide upon and discontinue the services of any workman employed by him on the work who does not possess satisfactory skill and qualifications, or is otherwise objectionable.

"INSPECTION AND ACCEPTANCE OF WORK.—Each bidder must understand that, should his proposal be accepted, the materials delivered, and the work performed by him, at any and all times during the progress of the work, and prior to the final acceptance of, and payment for, the same, shall be subject to the inspection of the Supervising Architect, or his authorized agent, with the full right to accept or reject any part thereof that, in the opinion of the Supervising Architect, or his authorized agent, is not strictly in accordance with the drawings and specification; and that he must, at his expense, within a reasonable time, to be specified by the Supervising Architect, remedy any defective or unsatisfactory material or work; and that in the event of his failure to do so, after notice, the Supervising Architect will have the full right to have the same done, and to charge the cost thereof to his account.

"Each bidder should understand that, should his proposal be accepted, inspection of or payment for any portion of the work embraced therein by the Supervising Architect, or his authorized agent, will not relieve him of responsibility to remedy any defective materials or workmanship at his expense, at any time before final inspection and acceptance of, and final payment for, all of the material and work contemplated by, and embraced in, his proposal.

"PATENT RIGHTS.—Each bidder must understand that he is to

protect and indemnify all persons acting for and in behalf of the United States for any liability which may be claimed by any party on account of any patent rights connected with any of the materials or articles used in the performance of the work contemplated by, and embraced in, his proposal.

"CERTIFIED CHECK.—Each bidder must submit with his proposal a certified check for a sum not less than 2 per cent of the amount of proposal, drawn to the order of the Treasurer of the United States, as a guaranty that he will fully and faithfully comply with the terms of his proposal should the same be accepted, and that, within two weeks after the form is sent to him, he will execute either a formal bond or contract in accordance therewith, to be approved by the Secretary of the Treasury.

"The certified check of the successful bidder will be retained until the execution of a formal bond, or contract, and the approval of the same by the Secretary of the Treasury, and the certified checks of the unsuccessful bidders will be returned immediately after the proposal of the successful bidder shall have been accepted.

"Each bidder is hereby notified that a copy of the advertisement, 'General Instructions and Conditions,' specification, accepted proposal, and letter of acceptance of proposal, will be attached to, and form a part of, and the drawings properly signed, will form a part of, the formal bond, or contract, to be executed and approved.

"FORFEITURE OF CHECK.—Should the successful bidder fail to execute a formal bond, or contract, within two weeks after the same is sent to him, his certified check may be declared forfeited, and the letter of acceptance of his proposal may be revoked, and all obligations on the part of all persons acting for and in behalf of the United States in connection therewith will be released and annulled.

"PAYMENTS.—After the acceptance of a proposal, and execution and approval of a formal bond, or contract, monthly payment will be made on account of the work actually executed and in place in the building; and such payments will be made by the authorized agent of the Treasury Department, based upon the estimated value of the quantity of such work computed from the contract unit of value, less 10 per cent, to be retained until the entire and satisfactory completion, final inspection, and acceptance of all the materials and work embraced in the contract, at which time final payment of the balance due will be made; but no payment will be made for any materials delivered and not actually put in place.

"PAYMENTS FOR HEATING APPARATUS.—After the acceptance of a proposal, and execution and approval of a formal bond, or contract, monthly payment of 80 per cent will be made on account of the work actually executed and in place in the building; an additional payment of 10 per cent will be made upon completion of a test of the heating apparatus, at the contractor's expense; and the final payment of 10 per cent will be made after the heating apparatus shall have been operated for one heating season; all to the satisfaction of the Supervising Architect or his authorized agent.

"PROTECTION OF WORK AND MATERIALS.—The successful bidder will be responsible for the proper care and protection of all materials delivered and work performed by him until the completion and acceptance of, and final payment for, all of the work embraced in his proposal; and part payments, on account of such materials and work, will not in any way relieve him of such responsibility.

"RIGHTS RESERVED.—The Supervising Architect reserves the right to waive any informalities in any proposal that may be received, and to reject any or all proposals submitted in response to the advertisement.

"EIGHT-HOUR LAW." (See p. 1.)

"SUBCONTRACTORS.—Each bidder is hereby notified that if his proposal is accepted, and he is required to execute a formal bond, or contract, that the Supervising Architect and the Secretary of the Treasury will only recognize him, and will not recognize any subcontractors, party furnishing material, or workmen engaged by him in connection with the work embraced in his proposal in any manner pertaining to the transaction of any business, or the adjustment of any accounts, or of any payments, on account of the work, except as provided for in the

following Act of Congress, approved August 13, 1894." (Here follows the act; see p. 1.)

"INDORSEMENT.—Each proposal must be inclosed in an envelope, sealed, and indorsed:

"Proposals for the

and addressed to

"THE SUPERVISING ARCHITECT,

"*Treasury Department*,

"*Washington, D. C.*

"NOTICE TO BIDDERS.—Bidders who send their bids to this office through the mails are requested to register same, and to place their name, address, and title of bid on the outside of the envelope for identification; and to mail such proposal sufficiently early to reach its destination by the time required, as it is a frequent occurrence that proposals reach this office after the hour required. All proposals received after the time stated in the advertisement will be returned unopened to the bidder if the proper name and address is known, but if not, it will be necessary to open same for such name and address."

BONDS.

Instructions for Preparation of Bonds to accompany Contracts.—"1. The Christian name must be written in the body of the bond in full, and so signed to the bond.

"2. A seal of wax or wafer must be attached to each signature on the bond. No seals required for signatures to contract except contract seals.

"3. Each signature must be made in the presence of two persons, who must sign their names as witnesses.

"4. Each surety must make and sign an affidavit of the amount he is worth after paying his just debts and deducting all exemptions by the laws of the State in which he resides, and liabilities of whatever nature, as per form herewith. (See form, Chap. VIII.)

"5. A district judge or attorney of the United States or clerk of a United States court must certify that the sureties are sufficient to pay the penalty of the bond.

"6. The affidavits of the sureties must be taken and signed before an officer authorized to administer oaths generally. The officer must certify that he administered the oaths. If the magistrate is not a judge of the United States court, his authority to administer oaths must be certified by the clerk of a court of record having official knowledge of that fact.

"7. Bond must be dated.

"8. Residence of principal and sureties must be distinctly stated.

"9. The sureties must justify in amounts the aggregate of which will be equal to twice the penal sum of the bond.

"10. When the contracting party is a partnership concern the contract must be signed with the firm name without seal, and the bond must be signed by each member of the firm with seal to each signature; when a corporate body, there should be attached to the contract duly authenticated evidence that the officer or officers executing the contract and bond have authority to do so, and the corporate seal must be affixed to each instrument."

"(*Circular* 1891, *Department No.* 178. *Supervising Architect's Office.*)

"INSTRUCTIONS TO PUBLIC OFFICERS APPOINTED TO DISBURSE MONEYS APPROPRIATED FOR THE CONSTRUCTION OF PUBLIC BUILDINGS.—

"TREASURY DEPARTMENT, OFFICE OF THE SECRETARY,
"WASHINGTON, D. C., *November* 17, 1891.

"I. In accordance with the regulations of the Department, issued under sections 3620 and 5488 of the Revised Statutes, all remittances to a disbursing agent must, immediately upon receipt thereof, be deposited to his credit with the Treasurer or an Assistant Treasurer of the United States or a designated depositary, unless specially authorized by the Secretary of the Treasury.

"II. Funds required for the prosecution of work will be advanced upon the estimates of the superintendent in charge, which estimates

are required to be placed in the hands of the disbursing agent on or before the first day of the month for which made, for record and transmission to this Department. Upon this paper the disbursing agent will note, in the marginal blank prepared for that purpose, the total amount of funds received, the amount paid for site, the amount paid on superintendent's certificates, the amount of repayments to the Treasury, the amount retained as commissions on disbursements, and the balance on hand.

"III. Moneys advanced to the disbursing agent will be paid out only upon vouchers properly certified by the superintendent, except in the case of the disbursing agent's commissions, unless otherwise specially instructed by the Secretary of the Treasury. Disbursing agents are accountable under their bonds for the safe custody and proper disbursement of the moneys advanced to them. In no case will moneys be placed in the hands of a superintendent for disbursement."

. . . . . .

"V. Vouchers are prepared in favor of the person, firm or corporation with whom the obligation has been contracted; the receipt for the amount must strictly correspond therewith, and be made by the person or one of the persons, to whom the money is due. Vouchers drawn in favor of a firm should be receipted by a member of the firm in the firm's name, and if he adds thereto his own name, he should also add the words 'of the firm.' In case payment is directed to be made to an attorney, a duly executed power of attorney, or properly attested copy, must be furnished, to accompany the voucher which it covers when the accounts are rendered. As powers of attorney are strictly construed they should be so explicit in terms as to leave no room for doubt as to the extent of authority intended by the principal to be delegated. When the public creditor is a corporate body supplying materials or services under contract, the first voucher should be accompanied by a properly authenticated copy, under seal, of the vote or order of the corporation authorizing the person signing to so make the corporate signature and receive the money. Subsequent vouchers under the same contract will bear upon their face a reference to this authority already furnished. When the payee is unable to write he will make his signature by mark, and such signature must be properly attested.

"VI. Payment will not be made to heirs, executors, administrators, receivers, assignees, or other successors or legal representatives (except in the case of attorneys referred to in the preceding section), until the account has been passed upon by the proper accounting officers of the Treasury. To enable these officers to acquire a full understanding of the subject, and to take such action as the laws and regulations prescribe in such cases, the account, covered by full letter of explanation, must be sent to this Department, accompanied by the original letters of administration (if any are issued), or properly authenticated order of the court, as the case may be, when, after consideration, instructions as to payment will be given.

"VII. The disbursing agent should attend personally, wherever practicable, to the paying out of all moneys. Receipts to the payments, as well as other vouchers, except in the case of nonresident creditors, should be made in his presence, or in that of some trusty person whom he may deputize for that purpose. Immediate payment should be made to all mechanics and laborers at the time of signing the rolls.

. . . . . .

"X. The disbursing agent will not regard processes of attachment against public funds, nor under any circumstances pay into the hands of a creditor of an employee in the public service any moneys due such employee except upon a duly executed power of attorney.

"XI. Before making payment of any voucher, the disbursing agent should give it careful scrutiny to see that it is in proper form, that its computations are correct, that the expenditures are incurred under proper authority, and that the prices are charged in accordance with contract rates; and when any fact comes to the knowledge of the disbursing agent tending to show that the services or supplies

charged for have not been actually rendered or delivered, or are not at fair or contract prices, or that the expenditure is extravagant or unauthorized, it will be his duty, notwithstanding the voucher therefor may bear the certificate of the superintendent, to withhold payment and report the case to the Department for Instructions." . . .

"XV. The attention of disbursing agents is specially directed to the following-named sections of the Revised Statutes of the United States: 3618, 3620, 3621, 3622, 3623, 3624, 3633, 3733, 5488, 5491, 5496, and 5503, and to Department Circular No. 107, August 24, 1876.

"O. L. SPAULDING,

"*Acting Secretary.*"

FEDERAL BUILDINGS.

Federal buildings differ materially in size and arrangement. All are of the best materials, and built so as to be strong, and generally of fire-proof or slow-burning construction. Specifications are like those used by the best architects generally, and the construction methods are those in general use throughout the country. The following extracts from the specifications for the United States Custom-house and Post-office Building at Houlton, Maine, are given as fairly typical, and will show the general character of the work required. The limit of cost was fixed at $66,000 in the Act of March 3, 1893. The site cost $6000.

EXTRACTS FROM SPECIFICATIONS.

Engineer.—"The contractor must employ a competent engineer or surveyor to establish benches at corners of lot, and to verify all lines and levels shown on the drawings, and properly locate all building-lines and pay all charges for same; also furnish the engineer's certificate to the superintendent that the lines and levels are accurate and in accordance with the drawings, and municipal regulations, also to test the levels of the work at the bottom of the general excavation, and the several floor and main cornice lines as the walls are built, and furnish certificates of such tests, stating the levels to be correct."

Masonry.—Where the bed is rock it is to be properly prepared, and the walls are to be built on it without footing-courses. In other cases a concrete bed is to be made, with one part cement, two sand, and five broken stone. The footing-course is to be of through-stones, roughly cut to even bed and vertical joints. The remainder of the foundations is of rubble in 2′ courses, $\frac{3}{4}''$ joints, with two through-stones in each superficial yard of wall. All of the stone in the walls of the building is of granite. After the foundation-walls are built, 3″ drain-pipes are to be laid around the exterior of the building on a 6″ bed of concrete, and connected with the sewer. Dwarf-walls are to butt into chases, 2″ deep, in the main walls, and are not to be bonded to them.

The walls are of brick, trimmed with cut granite. The exposed walls are of approved quality, red pressed brick, laid as stretchers, and clip-bonded with the backing at every fifth course. All facing-brick is required to be laid from a scaffold in front, with $\frac{1}{8}''$ joints, neatly V-pointed as the work progresses. The exterior walls of the first and second stories are hollow, one and one-half bricks thick (1′ 10″) in exterior portion, and one brick thick (8″) in interior portion, with a 2″ air-space. The backing is of best quality common brick, square, sound, uniformly hard-burned, firm in texture, even in size, and free from limestone pebbles. All of the backing is laid in a first-class manner, bonded throughout with headers every fifth course, and with solid joints of mortar all around, not more than $\frac{1}{4}''$ thick. The exterior and interior walls are tied together with brick withes (headers), 2′ high, every two feet, arranged in the various courses in quincunx order. The arches for interior reveals of openings in exterior walls, and the arches of openings in interior walls, are of full depth of reveals and thickness of walls, and in half-brick rings. Small openings into heating and ventilating flues and vent-shaft have flat arch headers. The arches of the first floor over the boiler-room, and the trimmer arches, are of half-brick rings. The arches of the

floors and ceilings of vaults and lookouts are of two half-brick rings. The arches of the first floor have purpose-made skewbacks, fitting the flanges of the beams. The centres for the arches are not to be struck until the mortar is thoroughly set. The centres of arches of openings in interior walls, where the openings are to have square finish, are left in place, as grounds for joiner-work.

The mortar for all stone, brick, and terra-cotta work, except for pressed-brick facings, is of one third cement and two thirds clean, sharp sand. Pressed brick is laid in best quality, red pulp mortar.

All cement, except for top-coat work of basement and area floors, and pointing of face-joints of stonework, is of best quality of American hydraulic cement, having a tensile strength of not less than 150 lbs. per square inch, when tested in neat briquettes, after exposure of one day in air and six in water. Cement for other work is of the best quality of American Portland cement, having a tensile strength of not less than 300 lbs. per square inch tested in the same manner.

Window and door openings have beam lintels of stated dimensions, with the ends resting on 1″ thick bearing-plates. Where the lintels consist of more than one beam, iron separators must be used. Wood filling-pieces are bolted to the lintels, for grounds for joiner-work.

Some of the columns in the building are covered with porous terra-cotta. All of the terra-cotta is required to be of best quality, moulded fair and true, thoroughly and evenly burned, and free from cracks and defects.

Floors.—The basement is floored with concrete. The other floors are of wood, except in a portion of the first floor. The floor-girders, beams, and joists are supported on the walls and on cast-iron columns. The cast-iron columns are required to be plumb and true, and of uniform thickness. The bearing surfaces, heads, base-plates, etc., are turned smooth and at right angles to the axis. Bases and heads are finished true and smooth, to fit into the core of the columns. The columns rest on cast-iron bearing plates, set true and level in cement on footing or cap stones.

Girders are built of I-beams and have cast-iron separators, of standard shapes, 1″ thick, fitting the profiles of the beams, and not more than 6′ apart. The beams are bolted together through the separators, with $\frac{3}{4}$″ bolts. Beams and girders, resting on cast-iron brackets of columns, are bolted through the webs of the lugs of the brackets, and have full bearing. The ends of beams have 8″ bearings on the walls, on cast-iron plates, 12″ × 8″ × 1″. The girders bear on the walls on granite bearing-blocks of stated dimensions. The ends of all iron girders on walls are anchored with $\frac{3}{4}$″ iron rods, 3′ long, bent to the required shape.

The floor and ceiling arches of vaults and lookouts have 1″ tie-rods, with threaded ends, nuts and washers, and pass through gib-plates at the ends, built into the masonry. The floor-beams over the boiler-room are tied together with $\frac{3}{4}$″ rods, with nuts and washers. All framing of steel and iron work is fully described in the drawings. Connections are generally made with two angles and rivets. Where it is not convenient to rivet, bolts may be used. Rivet-holes are to be accurately punched or drilled. Bolts and nuts are to be forged of double refined wrought iron. Rivets are of steel, with cup heads. All fastenings of ironwork to the masonry are made with expansion bolts.

The beams are of mild steel, best quality, of American manufacture, and must have an ultimate tensile strength of 60,000 to 68,000 lbs. per square inch, and an elastic limit of not less than one half the ultimate tensile strength in pounds. All of the rolled-iron beams, channels, angles, etc., are of the best quality of American manufacture, straight and true, and with an ultimate tensile strength of 46,000 lbs. per square inch. All cast iron is of best quality; castings to be sharp, clean, and free from cracks, bubbles, and other defects.

No wood blocks or wedges are allowed for levelling up ironwork. Iron must be used in all cases.

All lumber for floor-joists, etc., is to be of pine, thoroughly seasoned, straight-grained, and free from sap, shakes, and large or

loose knots. The floor-joists are cambered $\frac{1}{4}''$ for each 10′ of span, and have at least 4″ bearing in the walls, with the ends in the wall cut to slope 3″. The cross-bridging is of $1\frac{1}{4}'' \times 3''$ stuff. Joists abutting in walls are tied together with wrought-iron straps, $2' \times 2'' \times \frac{3}{8}''$, secured with two $\frac{3}{4}''$ bolts. Where required, the ends of joists are carried with full bearing, in wrought-iron stirrups, of $2'' \times \frac{3}{8}''$ strap. Where required, joists are anchored at both ends into the brickwork with wrought-iron anchors. Slate is used for levelling up under the ends of joists.

The floors of the first and second stories, except where marble tiling is used and over the iron beams and arches, have a rough under flooring of $\frac{7}{8}''$ stuff, 6″ wide, laid diagonally, butt-jointed, and dressed on the upper side. This is covered with one thickness of best quality of two-ply rosin-sized paper, well lapped and tacked down. The top flooring of the halls and main rooms is of best quality of maple flooring, thoroughly seasoned, kiln-dried, $\frac{7}{8}''$ thick, not more than $2\frac{1}{4}''$ face width, dressed, tongued and grooved, bored for nails, laid close, and blind-nailed.

Flues.—All framing is to be kept at least 2″ clear of any heating flue. Heating and ventilating flues are lined with No. 24, B.W.G., galvanized iron, with joints strongly soldered and riveted, carried up ahead of the brickwork, and at all times kept free from mortar. The interior of smoke flues is kept even and true, with all joints neatly trowelled.

Roof.—The main roof, and sides and roofs of dormers, are covered with best quality, straight-grained, clear, pine plank, tongued and grooved sheathing, $1\frac{1}{4}''$ thick, and free from large knots, sap, and defects. This sheathing is covered with one layer of best quality fibre paper, or red-rosin-sized sheathing-paper, weighing 12 ounces to the square yard, well lapped and tacked on. The slate is best quality, No. 1, Monson, Maine, of uniform blue or black, fast color, in pieces $10'' \times 16'' \times \frac{1}{4}''$, split, with surfaces true and out of wind, and edges and tails cut square and straight. This is laid $6\frac{1}{2}''$ to the weather. The flashings are of IX tin, terne plates, of best quality American manufacture.

Plaster.—The furring is of $1'' \times 2''$ strips, spaced 12″ between centres. The lathing is either galvanized-iron wire-cloth lathing, of No. 18, B.W.G., wire, $\frac{3}{8}''$ mesh, and stiffened every 7″, or of corrugated sheet iron, perforated for plastering, or "expanded metal" lathing. The grounds for the plastering must allow for $\frac{3}{4}''$ thickness of plaster. The plastering of all of the walls and ceiling is three-coat work, hard finish, with lime putty and clean, white, sharp sand, without plaster of Paris. King's Windsor cement is allowed for the entire work in lieu of lime.

The mortar for the plaster is composed of best quality, white, wood-burned, stone lime, slaked at least 14 days before using, and run through a fine sieve. This is thoroughly mixed with the sand in the proportion of $\frac{1}{3}$ lime to $\frac{2}{3}$ sand. The first coat has $1\frac{1}{2}$ bushels of clean, long, cattle hair to 1 barrel of unslaked lime. The hair is well wetted and mixed with the mortar just before using. The second coat has $\frac{1}{2}$ bushel of hair to 1 barrel of lime.

Miscellaneous.—The plumbing is required to be of the first quality and as prescribed in the specifications. The interior finish is also fully described. The building is heated by steam, low pressure, return circulation. The heating and ventilating apparatus were bought and placed under a separate contract.

Tabular Statement of Custom-houses, Court-houses, Post-offices, Marine Hospitals, etc., under Charge of the Treasury Department, Exhibiting the Actual Cost of Construction, Cost of Alterations and Repairs, Total Cost of Work, Including Alterations and Repairs, June 30, 1893, Cost of Site, and Date of Purchase of Same, from Report of Supervising Architect, 1893.

Location.	Nature of Work.	Actual Cost of Construction.	Cost of Alterations and Repairs.	Total Cost of Work to June 30, 1893.	Cost of Site.	Date of Purchase.	Remarks.
Aberdeen, Miss...	Court-house, post-office, etc.....	$74,661.34	$162.90	$74,824.24	$4,102.48	June 30, 1885	
Abingdon, Va.....	....do.....	73,600.47	279.15	73,879.62	13,210.03	Nov. 24, 1884	
Albany, N. Y.....	Custom-house and post-office....	623,565.21	31,705.05	655,270.26	155,700.90	May 11, 1874	
Alexandria, La....	Post-office.....	.....	.....	819.58	3,841.90	July 31, 1891	Sketch plans and estimates made and approved; working drawings not yet begun.
Alexandria, Va...	Custom-house and post-office....	57,913.64	21,084.64	78,998.28	16,000.00	May 23, 1856	
Atlanta, Ga.....	Court-house and post-office.....	273,734.50	148,469.94	422,204.44	20.59	June 1, 1874	Site donated; extension completed.
Augusta, Ga.....	....do.....	121,354.20	1,944.33	123,298.53	30,329.37	Aug. 4, 1887	
Augusta, Me.....	Post-office, court-house, etc.....	178,281.20	5,228.46	183,509.66	18,264.49	June 27, 1885	
Austin, Tex.....	Court-house and post-office.....	185,767.52	6,263.95	192,033.47	.....	Aug. 1, 1887	Site donated.
Auburn, N. Y.....	Post-office, court-house, etc.....	149,620.90	193.46	149,814.36	50,606.17	Jan. 5, 1887	
Asheville, N. C...	Court-house and post-office.....	99,087.92	13.80	99,101.72	295.35	Feb. 9, 1889	Do.
Astoria, Oregon..	Custom-house, etc.....	67,986.28	9,082.03	77,068.31	7,000.00	May 7, 1868	
Do.....	....do.....	.....	.....	.....	900.00	May 27, 1856	Old site.
Alaska	Building at Juneau.....	.....	2,650.00	2,650.00	.....	.....	Acquired from Russia.
Do.....	Seal fisheries.....	5,212.21	167.46	5,379.67	.....	.....	Acquired from Russia; one building on St. Paul Island, and one on St. George Island for special agent of Treasury.
Do.....	Buildings at Wrangle.....	.....	1,260.00	1,260.00	.....	.....	Acquired from Russia.
Do.....	Buildings at Kodiak.....	.....	624.00	624.00	.....	.....	Transferred from War Department, Aug. 3, 1875.
Do.....	Buildings at Sitka.....	.....	27,297.94	27,297.94	.....	.....	Acquired from Russia, 27 buildings.
Do.....	Buildings at Ounalaska	.....	1,000.00	1,000.00	.....	.....	Acquired from Russia.
Do.....	Custom-house, Mary Island and Sand Point.....	14,896.85	217.24	15,114.09	.....	.....	Government reservation.
Akron, Ohio.....	Post-office.....	.....	.....	1,152.50	10,179.56	May 10, 1892	Sketch plans and estimates made and approved; working drawings not yet begun.
Allegheny, Pa....	....do.....	.....	.....	83.01	175,249.87	Feb. 1, 1893	No sketch plans or other drawings made.
Ashland, Wis.....	....do.....	.....	.....	47,667.03	6,059.37	Jan. 23, 1891	In course of construction.
Atchison, Kans...	....do.....	.....	.....	47,939.59	14,606.89	Mar. 19, 1891	Do.
Aurora, Ill.....	....do.....	.....	.....	18,929.81	20,312.26	Sept. 14, 1891	Do.
Bath, Me.....	Custom-house and post-office....	84,830.23	36,206.30	121,036.53	15,000.00	Jan. 3, 1853	
Bangor, Me.....	....do.....	84,512.13	145,526.14	230,038.27	15,000.00	June 5, 1851	
Barnstable, Mass..	....do.....	34,433.71	5,280.01	39,713.73	1,500.00	Apr. 24, 1855	
Baltimore, Md....	Custom-house.....	.....	382,456.24	382,314.51	*10,000.00 170,000.00 200,002.00	Jan. 16, 1817 Feb. 10, 1853 May 27, 1857	Merchants' Bank property.
Do.....	Court-house.....	205,176.97	42,351.71	247,528.68	5,000.00	June 6, 1849	Authorized to be sold, Act July 9, 1890.
Do.....	Marine hospital.....	100,844.24	4,594.30	105,438.54	21,238.00	May 24, 1884	
Do.....	Appraisers' stores.....	241,672.61	22,973.13	264,645.74	30,000.00	June 10, 1823	
Do.....	Post-office, court-house, etc.....	1,530,640.09	3,584.38	1,534,224.47	553,500.00	July 26, 1880	Building in course of construction.
Belfast, Me.....	Custom-house and post-office....	30,983.26	22,224.77	53,208.03	5,000.00	Oct. 4, 1852	
Binghamton, N. Y.	Post-office, court-house, etc.....	137,681.82	485.40	138,167.22	15,202.53	Dec. 31, 1887	
Birmingham, Ala..	Court-house and post-office.....	271,555.46	.....	271,555.46	53,569.75	Feb. 11, 1889	Do.
Boston, Mass.....	Custom-house.....	884,346.76	322,831.10	1,207,177.86	180,000.00	Aug. 29, 1837	
Do.....	Post-office and sub-treasury.....	4,623,122.47	112,927.49	4,736,049.96	1,329,095.84	Apr. 14, 1868 Dec. 24, 1874 July 31, 1875	
Do.....	Chelsea marine hospital.....	233,015.31	149,799.09	382,814.40	50,000.00	Dec. 8, 1858	Laundry apparatus in course of construction.
Boise City, Idaho.	Assay office.....	77,252.00	1,228.72	78,551.62	.....	Nov. 6, 1869	Site donated,
Brooklyn, N. Y...	Post-office.....	1,496,383.67	576.63	1,496,960.30	413,594.12	Apr. 15, 1884	Building in course of construction.

Tabular Statement of Custom-houses, Court-houses, Post-offices, Marine Hospitals, etc.—Continued.

Location.	Nature of Work.	Actual Cost of Construction.	Cost of Alterations and Repairs.	Total Cost of Work to June 30, 1893.	Cost of Site.	Date of Purchase.	Remarks.
Bristol, R. I.....	Custom-house and post-office....	$22,135.75	$11,148.67	$33,284.42	$4,400.00	Mar. 12, 1856	
Buffalo, N. Y.....	....do.....	150,839.09	349,087.42	499,926.51	45,000.00	Jan. 22, 1855	
Do.....	Post-office.....	.....	.....	.....	477,884.45	Dec. 8, 1891	No sketch plans or other drawings made.
Burlington, Iowa..	....do.....	.....	.....	14,823.22	20,176.73	Feb. 21, 1891	In course of erection.
Burlington, Vt....	Custom-house and post-office....	44,714.91	34,905.11	79,620.02	7,750.00	Mar. 5, 1855	
Bridgeport, Conn.	Post-office.....	124,729.92	157.84	124,887.76	25,154.05	Dec. 20, 1888	
Bay City, Mich....	Court-house, post-office, and custom-house.	125,446.48	.....	125,446.48	40,442.81	Nov. 23, 1889	Building in course of construction.
Brownsville, Tex..	Court-house, custom-house, and post-office.	54,711.96	.....	54,711.96	55.20	1889	Site donated; completed since last report.
Baton Rouge, La..	Post-office.....	.....	.....	2,081.75	15,442.31	Oct. 10, 1891	Sketch plans and estimates made and approved; working drawings not yet begun.
Beatrice, Nebr....	....do.....	45,919.89	.....	45,919.89	15,041.74	July 27, 1891	Building in course of construction.
Beaver Falls, Pa..	....do.....	.....	.....	78.75	11,072.77	Sept. 1, 1892	No sketch plans or other drawings made.
Bloomington, Ill..	....do.....	.....	.....	3,064.19	8,180.86	Sept. 7, 1891	Sketch plans and estimates made and approved; working drawings not yet begun.
Cairo, Ill.....	Custom-house and post-office....	281,044.14	31,923.94	312,968.08	.....	Apr. 28, 1866	Site donated.
Do.....	Marine hospital.....	76,205.73	7,375.50	83,581.23	15,031.40	Oct. 4, 1883	
Castine, Me.....	Custom-house and post-office....	1,950.00	16,490.08	18,440.08	1,800.00	Apr. 6, 1833	
Carson City, Nev.	Branch mint.....	426,787.66	7,582.72	434,370.38	.....	May 3, 1865	Site donated; total cost includes machinery.
Do.....	Custom-house, post-office, etc...	128,904.45	137.72	129,012.17	11,118.13	Mar. 1, 1886	
Charleston, S. C..	Custom-house.....	2,696,592.34	257,811.11	2,954,403.45	130,000.00	July 10, 1849	Wharf completed.
Do.....	Old post-office.....	.....	25,572.56	25,572.56	*60,000.00	Feb. 14, 1818	Damaged by earthquake, Aug. 31, 1886; authorized to be sold on completion of new building. (Vol. 24, p. 394, Act Feb. 7, 1887.)
Do.....	Club-house.....	.....	3,059.19	3.059.19	46,000.00	1869	Transferred from War Department; building destroyed by earthquake Aug. 31, 1886.
Do.....	Post-office, court-house, etc.....	.....	.....	216,089.93	99,997.25	Jan. 2, 1887 May 25, 1888 Dec. 14, 1888	Building in course of construction.
Charleston, W. Va.	....do.....	80,879.40	55,022,64	135,902.04	8,100.00	Jan. 5, 1881	
Charlotte, N. C...	Assay office.....	31,572.97	27,637.58	59,210.55	15,000.00	Nov. 2, 1835	
Do.....	Court-house and post-office.....	91,797.39	205.55	92,002.94	.....	.....	Government reservation; completed since last report.
Chicago, Ill.....	Custom-house and sub-treasury.	4,553,215.91	566,588.97	5,119,804.88	1,259,385.65	Aug. 26, 1872	Extension and repairs in progress.
Do.....	Marine hospital.....	417,560.57	105,120.34	522,680.91	10,000.00	Jan. 10, 1855 Jan. 22, 1867	
Do.....	Appraisers' stores.....	334,060.11	1,280.96	335,341.07	70,939.89	Nov. 27, 1886	
Do.....	Barge office.....	.....	1,667.34	1,667.34	.....	.....	Transferred from War Department.
Do.....	Government buildings, World's Columbian Exposition.	398,960.90	.....	398,960.90	.....	.....	Use of site granted by city; completed since last report.
Cincinnati, Ohio..	Custom-house and post-office....	5,088,382.35	42,824.01	5,131,206.36	708,026.00	Nov. 8, 1873	
Do.....	Marine hospital.....	49,488.79	9,922.50	58,911.29	50,500.00	Nov. 9, 1882	
Cleveland, Ohio...	Custom-house, etc.....	138,236.30	390,958.56	529,194.86	30,000.00	Apr. 9, 1856	Alterations and repairs completed.
Do.....	Marine hospital.....	86,703.66	23,227.37	109,931.03	12,000.00	Oct. 11, 1837	Leased to private parties until 1895.
Columbus, Ga....	Post-office.....	.....	.....	15,309.95	14,205.47	Mar. 5, 1892	Building in course of construction.
Columbus, Ohio...	Court-house, post-office, etc.....	264,588.96	1,450.93	266,039.89	59,326.74	Oct. 1, 1882	
Council Bluffs, Ia.	Post-office, etc.....	232,437.94	1,847.02	234,284.96	15,294.56	....do.....	
Columbia, S. C....	Court-house and post-office.....	407,189.17	9,172.36	416,361.53	5,000.00	Mar. 31, 1869	
Covington, Ky....	....do.....	264,231.01	16,591.87	280,822.88	30,660.48	Oct. 6, 1873	

* Building and site.

Tabular Statement of Custom-houses, Court-houses, Post-offices, Marine Hospitals, Etc.—Continued.

Location.	Nature of Work.	Actual Cost of Construction.	Cost of Alterations and Repairs.	Total Cost of Work to June 30, 1893.	Cost of Site.	Date of Purchase.	Remarks.
Concord, N. H....	Post-office, court-house, etc.....	$174,465.79	$2,338.87	$176,804.66	$52,675.63	July 31, 1883	
Clarksburg, W.Va.	Court-house, post-office, etc.....	79,838.51	410.00	80,248.51	3,628.67	July 1, 1885	
Clarksville, Tenn.	Post-office.....	.....	.....	.....	163.19	.....	Site not yet purchased.
Canandaigua, N.Y.	Court-house and post-office.....	.....	71.35	71.35	.....	.....	Perpetual lease granted the United States of a portion of the county court-house for use as a court-house and post-office in consideration of $30,000. (Vol. 11, p. 84; Vol. 17, p. 419; Statutes at Large.)
Camden, Ark.....	Post-office.....	.....	.....	866.74	4,137.48	May 28, 1892	Sketch plans and estimates made and approved; working drawings not yet begun.
Camden, N. J.....	Post-office, custom-house, etc....	.....	.....	3,600.66	30,803.12	May 18, 1888	Working drawings finished two years ago. Work suspended at request of members of Congress and citizens, for extension of limit.
Chattanooga, Ten.	Court-house, post-office, etc.....	274.606.26	45.75	274,652.01	210.23	Sept. 13, 1887	Site donated.
Canton, Ohio.....	Post-office.....	.....	.....	59,016.39	22,344.58	Mar. 19, 1891	Building in course of construction.
Cedar Rapids, Ia..	....do.....	.....	.....	39,845.47	24,185.94	Feb. 11, 1891	Do.
Chester, Pa.....	Post-office.....	.....	.....	8,128.65	15,400.10	Oct. 23, 1891	Building in course of construction.
Dallas, Tex.....	Court-house, post-office, etc.....	129,205.64	56,303.96	185,509.60	11,346.95	Apr. 23, 1883	$2,000 of cost of site donated by citizens. Extension in course of construction.
Danville, Ill.....	Post-office.....	.....	.....	35,157.85	16,655.28	Jan. 2, 1892	Building in course of construction.
Danville, Va.....	Court-house, post-office, etc.....	97,799.56	5,182.25	102,981.81	14,500.00	Apr. 21, 1880	
Dayton, Ohio.....	Post-office.....	117,894.94	238.91	118,133.85	42,626.09	Jan. 9, 1888	
Des Moines, Iowa.	Court-house and post-office.....	217,023.24	345,593.99	562,617.23	15,000.00	Oct. 6, 1866	
Denver, Col.....	Court-house, post-office, etc.....	565,952.54	174.10	566,126.64	65,825.17	May 25, 1883	
Do.....	Branch mint.....	68,377.69	1,870.00	70,247.69	25,000.00	Nov. 25, 1862	
Detroit, Mich.....	Custom-house, etc.....	182,733.00	51,832.32	234,565.32	24,000.00	Nov. 13, 1855	Authorized to be sold on completion of new building. (Stat. L., Vol. 23, p. 338.)
					88,546.42	Mar. 19, 1883	
Do.....	Court-house and post-office.....	.....	.....	412,089.00	401,258.38	Dec. 2, 1885 / Nov. 25, 1887	Building in course of construction.
Do.....	Marine hospital.....	78,258.64	27,087.63	105,346.27	23,000.00	Mar. 19, 1885	Enlargement, etc.; authorized Act Aug. 5, 1892; drawings not yet made.
Dover, Del.....	Post-office.....	51,320.87	7,247.89	58,568.76	10,498.55	July 3, 1878	
Dubuque, Iowa...	Custom-house and post-office....	174,687.50	32,483.20	207,170.70	20,000.00	Feb. 14, 1857	
Duluth, Minn.....	Court-house, custom-house and post-office.	.....	.....	163,264.11	18,583.40	Dec. 5, 1888	Building in course of construction.
Davenport, Iowa..	Post-office.....	.....	.....	17,782.73	6,397.17	Sept. 22, 1891	Do.
Eastport, Me.....	Custom-house and post-office....	108,021.19	.....	108,021.19	9,884.28	May 27, 1887	Completed since last report.
Erie, Pa.....	....do.....	.....	12,882.12	12,882.12	*29,000.00	July 2, 1849	
Do.....	Court-house, post-office, etc.....	217,019.35	261.34	217,280.69	36,488.60	Apr. 9, 1883	
Evansville, Ind...	Custom-house and post-office....	235,461.52	10,117.64	245,579.16	98,916.15	Mar. 14, 1873 / Feb. 26, 1874	
Do.....	Marine hospital.....	91,006.48	877.53	91,884.01	8,901.45	July 2, 1889	
El Paso, Tex.....	Custom-house, post-office, and court-house.....	188,641.12	48.55	188,689.67	10,375.94	Feb. 18, 1887	Building in course of construction.
Ellsworth, Me....	Custom-house and post-office....	20,060.77	16,156.25	36,217.02	3,000.00	Apr. 11, 1855	
Ellis Island, New York Harbor....	See New York.....	.....	.....	.....	.....	.....	
Emporia, Kans....	Post-office.....	.....	.....	.....	9,698.84	Feb. 25, 1893	Site purchased.
Fall River, Mass..	Custom-house and post-office....	360,135.54	14,345.38	374,480.92	163,392.17	June 20, 1873 / Jan. 12, 1884	
Frankfort, Ky....	Court-house and post-office.....	113,407.43	974.00	114,381.43	17,828.72	Dec. 6, 1882	

* Building and site.

Tabular Statement of Custom-houses, Court-houses, Post-offices, Marine Hospitals, Etc.—Continued.

Location.	Nature of Work.	Actual Cost of Construction.	Cost of Alterations and Repairs.	Total Cost of Work to June 30, 1893.	Cost of Site.	Date of Purchase.	Remarks.
Fargo, N. Dak....	Post-office and custom-house....	.....	.....	$2,489.01	$4,107.94	Feb. 4, 1892	Working drawings for foundation and basement finished, and work advertised.
Fort Wayne, Ind..	Court-house and post-office.....	$196,373.51	$495.16	196,868.67	34,322.12	May 13, 1883	
Fort Scott, Kans..	....do.....	109,454.39	170.68	109,625.07	22.99	June 11, 1885	Site donated.
Fort Smith, Ark...	Court-house, post-office, etc.....	115,933.23	5,886.07	121,819.30	.....	.....	Government reservation.
Do.....	United States jail.....	54,998.15	1,156.64	56,154.79	.....	.....	Do.
Fort Monroe, Va..	Post-office.....	.....	197.50	197.50	.....	.....	Do.
Fort Dodge, Iowa.	....do.....	.....	.....	23,348.30	3,650.58	June 10, 1891	Building in course of construction.
Fort Worth, Tex..	....do.....	.....	.....	38,463.20	10,694.50	May 15, 1891	Do.
Fremont, Nebr....	....do.....	.....	.....	8,733.37	6,063.81	July 24, 1891	Do.
Galena, Ill.....	Custom,house and post-office....	61,372.44	12,297.34	73,669.78	16,500.00	Mar. 24, 1859	
Galesburg, Ill.....	Post-office.....	.....	.....	12,010.79	9,778.54	June 29, 1891	Do.
Galveston, Tex....	Old custom-house.....	108,359.82	60,155.55	168,515.37	6,000.00	Sept. 1, 1855	
Do.....	Custom-house, etc.....	239,651.98	92.05	239,744.03	30,606.71	Nov. 7, 1883 July 6, 1885	Do.
Gr'd Rapids, Mich.	Court-house and post-office.....	141,413.03	5,943.86	147,356.89	69,996.00	Aug. 6, 1874	
Greensboro, N. C.	Court-house, post-office, etc.....	52,688.23	4,943.98	57,632.21	13,350.00	Apr. 26, 1883	
Gloucester, Mass..	Custom-house and post-office....	40,858.32	10,333.61	51,191.93	9,000.00	June 6, 1853	
Georgetown, D. C.	...do.....	55,368.15	17,932.68	73,300.83	5,500.00	Oct. 23, 1856	
Greenville, S. C...	Court-house and post-office.....	86,703.98	12.00	86,715.98	12,147.40	Feb. 14, 1889	
Hartford, Conn...	Custom-house and post-office....	846,802.21	6,465.23	853,267.44	.....	Oct. 3, 1872	Site donated.
Harrisburg, Pa...	Post-office, etc.....	290,056.44	17,680.26	307,736.70	110,927.88	Mar. 7, 1887	
Harrisonburg, Va.	Court-house, post-office, etc.....	100,057.74	151.30	100,209.04	12,329.60	Apr. 11, 1884	
Hannibal, Mo.....	Post-office.....	122,689.28	1,916.53	124,605.81	13,302.50	June 20, 1883	
Haverhill, Mass...	....do.....	.....	.....	4,861.82	20,363.59	May 25, 1892	Building in course of construction.
Helena, Ark.....	Court-house and post-office.....	63,878.45	.....	63,878.45	3,928.84	July 2, 1889	Do.
Helena, Mont.....	Assay office.....	58,506.18	1,279.20	59,785.38	1,540.00	Nov. 6, 1874	
Huntsville, Ala...	Court-house and post-office.....	89,726.35	738.50	90,464.85	10,103.12	June 27, 1887	
Houston, Tex.....	Post-office, etc.....	82,550.73	22.78	82,573.51	7,383.39	July 29, 1887	
Hoboken, N. J....	Post-office.....	42,240.53	53.30	42,293.83	31,071.55	Feb. 6, 1889	
Houlton, Me.....	Custom-house and post-office....	.....	.....	2,966.77	6,207.50	May 25, 1891	Do.
Indianapolis, Ind..	Court-house and post-office.....	166,240.00	229,626.01	395,866.01	17,160.00 30,000.00 149,935.03	Nov. 5, 1858 Mar. 14, 1875 May 16, 1889	
Jackson, Miss.....	....do.....	110,492.08	979.82	111,471.90	4,475.00	July 18, 1882	
Jackson, Mich....	Post-office.....	.....	.....	50,844.36	13,435.30	Sept. 9, 1889	Do.
Jackson, Tenn....	Court-house and post-office.....	60,976.87	4,819.08	65,795.95	6,813.07	Mar. 31, 1883	
Jacksonville, Fla..	Post-office, custom-house, etc...	.....	.....	159,964.29	40,599.53	July 12, 1888	Do.
Jersey City, N. J..	Court-house and post-office.....	.....	72,794.41	72,794.41	*71,383.05	Aug. 15, 1875	
Jefferson, Tex.....	....do.....	52,607.21	51.58	52,658.79	270.09	June 29, 1887	Site donated.
Jefferson City, Mo.	....do.....	143,162.68	922.60	144,085.28	10,310.55	Nov. 26, 1883	
Kalamazoo, Mich.	Post-office.....	68,848.47	172.00	69,020.47	6,117.20	Oct. 2, 1889	
Kansas City, Mo..	Custom-house, post-office, etc...	364,609.12	12,025.64	376,634.76	9,105.93	Apr. 7, 1879	
Do.....	Post-office and court-house.....	.....	.....	53,232.39	451,578.33	July 18, 1891	Building in course of construction.
Kennebec, Me.....	Custom-house and post-office....	.....	1,315.76	2,890.76	1,575.00	Nov. 9, 1832	Total cost includes site.
Key West, Fla....	Court-house.....	.....	.....	.....	3,091.74	Apr. 28, 1858	
Do.....	Court-house, post-office, etc.....	107,955.96	11.40	107,067 36	135.95	——— 1886	Site old custom-house.
Do.....	Marine hospital.....	25,100 00	23,839.45	48,939.45	500.00	Nov. 30, 1884	
Keokuk, Iowa.....	Court-house, post-office, etc.....	155,274.91	256.75	155,531.66	6,906.20	Aug. 15, 1885	

* Building and site.

Tabular Statement of Custom-houses, Court-houses, Post-offices, Marine Hospitals, etc.—Continued.

Location.	Nature of Work.	Actual Cost of Construction.	Cost of Alterations and Repairs.	Total Cost of Work to June 30, 1893.	Cost of Site.	Date of Purchase.	Remarks.
Knoxville, Tenn..	Court-house and post-office.....	$388,293.12	$18,060.21	$406,353.33	$10,300.00	Sept. 30, 1870 Mar. 3, 1871	
Lacrosse, Wis.....	Court-house, post-office, etc.....	134,822.94	1,564.30	136,387.24	12,160.20	July 14, 1885	
Lafayette, Ind....	Post-office.....	.....	.....	42,143.93	15,144.48	Mar. 11, 1891	Building in course of construction.
Lansing, Mich....	....do.....	.....	.....	56,601.67	18,798.67	Oct. 18, 1890	Do.
Lancaster, Pa.....	....do.....	84,013.24	202.50	84,215.74	15,860.74	Aug. 18, 1888	
Lexington, Ky....	Post-office, etc.....	124,927.67	2,739.65	127,667.32	20,330.47	Feb. 13, 1886	
Lincoln, Nebr.....	Court-house and post-office.....	198,243.98	15,896.67	214,140.65	436.35	Apr. 1, 1873	Site donated.
Louisville, Ky....	Custom-house, etc.....	246,640.75	131,817.13	378,457.88	16,000.00 6,500.00	Oct. 2, 1851 Sept. 8, 1875	
Do.....	Marine hospital.....	61,924.61	46,914.62	108,839.23	6,000.00	Nov. 3, 1842	Deadhouse, authorized Act Mar. 3, 1891; nothing done.
Do.....	Court-house, post-office, etc.....	1,100,767.95	.....	1,100,767.95	141,001.75	Jan. 29, 1883	Completed since last report.
Little Rock, Ark..	....do.....	221,390.93	6,602.32	227,993.25	29,729.25	May 25, 1873	
Leavenworth, Kan.	....do.....	168,870.92	10,051.11	178,922.03	10,412.45	May 31, 1883	
Lynchburg, Va....	....do.....	120,288.65	2,635.69	122,924.34	14,119.70	....do.....	
Los Angeles, Cal..	....do.....	123,890.11	21.95	123,911.86	28,634.33	July 7, 1887	
Lowell, Mass.....	Post-office.....	.....	.....	77,312.25	199.07	Apr. 18, 1889	Site donated; in course of erection.
Lewiston, Me.....	....do.....	.....	.....	7,556.09	16,472.19	Sept. 22, 1891	Building in course of construction.
Lima, Ohio.....	....do.....	.....	.....	3,192.62	10,152.33	Aug. 21, 1891	Drawings for the building under roof completed and specification in hand.
Lynn, Mass.....	....do.....	.....	.....	.....	26,405.48	Nov. 14, 1892	Title to site not perfected; no sketch plans made.
Macon, Ga.....	Court-house, post-office, etc.....	115,109.33	8,561.02	123,670.35	12,716.00	Aug. 14, 1885	
Machias, Me.....	Custom-house and post-office....	24,766.00	10,201.55	34,967.55	1,000.00	May 7, 1870	
Madison, Wis.....	Court-house and post-office.....	339,082.74	8,039.36	347,122.10	10,885.94	May 17, 1873	
Madison, Ind.....	Post-office.....	.....	.....	1,123.70	8,786.26	Nov. 12, 1891	No sketch plans or other drawing made.
Mankato, Minn...	Court-house and post-office.....	.....	.....	9,687.47	6,372.15	Sept. 29, 1891	Building in course of construction.
Martinsb'g, W. Va.	....do.....	.....	.....	19,045.75	9,460.22	June 8, 1891	Do.
Memphis, Tenn...	Custom-house, court-house, and post-office.....	520,500.00	61,670.11	582,170.11	.....	June 26, 1876	Site donated.
Do.....	Marine hospital.....	69,501.84	20,328.80	89,830.64	5,719.17	Aug. 10, 1882	
Middletown, Conn.	Custom-house and post-office....	12,176.64	24,627.72	36,804.36	3,500.00	Feb. 6, 1863	
Milwaukee, Wis...	....do.....	161,779.61	79,736.42	241,516.03	12,500.00	Feb. 16, 1855	Authorized to be sold, Act. Jan. 21, 1889. Sold Dec. 16, 1891, for $256,000; rented by Government until completion of new building.
Do.....	Post-office, court-house, and custom-house.	.....	.....	116,517.15	394,897.73	Oct. 31, 1890	Building in course of construction.
Mobile, Ala.....	Custom-house and post-office....	379,564.93	72,224.98	451,789.91	15,000.00	Oct. 3, 1851	
Do.....	Marine hospital.....	41,400.00	22,180.40	63,580.40	10,000.00	June 20, 1838 Aug. 25, 1856	Laundry machinery authorized, Act Mar. 3, 1891; nothing done.
Montgomery, Ala.	Court-house, post-office, etc.....	147,410.99	18,051.25	165,462.24	13,000.00	Nov. 8, 1880	
Minneapolis, Minn.	Post-office.....	548,678.21	12,305.64	560,983.85	92,514.56	Mar. 31, 1883 Aug. 24, 1884	
Manchester, N. H.	Post-office, court-house, etc.....	212,934.99	381.91	213,316.90	38,964.03	May 8, 1886	
Montpelier, Vt....	....do.....	144,670.61	250.53	144,921.14	15,178.76	Sept. 21, 1885	
Marquette, Mich..	Court-house, post-office, etc.....	92,273.05	271.45	92,544.50	7,276.60	May 9, 1883	
Monroe, La.....	....do.....	69,626.72	7.50	69,634.22	4,600.25	Apr. 16, 1889	
Meridian, Miss...	Post-office.....	.....	.....	1,773.15	6,151.22	Dec. 30, 1891	Sketch plans and estimates made and approved; working drawings in hand; half done.
Nashvillle, Tenn..	Custom-house and post-office....	404,684.44	21,044.38	425,728.82	38,500.00	Feb. 14, 1870 Apr. 29, 1876 June 7, 1877	

Tabular Statement of Custom-houses, Court-houses, Post-offices, Marine Hospitals, etc.—Continued.

Location.	Nature of Work.	Actual Cost of Construction.	Cost of Alterations and Repairs.	Total Cost of Work to June 30, 1893.	Cost of Site.	Date of Purchase.	Remarks.
Newark, N. J.....	Custom-house and post-office....	.....	.....	$182,207.22	$50,026.10 61,111.88	May 30, 1855 Aug. 31, 1888	Land additional to old site; old church on site fitted up for use as post-office; new building in course of erection.
New Albany, Ind..	Court-house and post-office.....	$89,816.56	$119.43	89,935.99	14,151.77	Sept. 25, 1885	
New Bedf'd, Mass.	Custom-house, etc.....	25,500.00	19,736.21	45,236.21	4,900.00	Apr. 9, 1883	
Do.....	Custom-house and post-office....	104,937.01	.....	104,937.01	43,921.35	Nov. 5, 1885 Feb. 7, 1889	Land additional to old site purchased and new building in course of erection.
Newburyp't, Mass.	....do.....	20,188.50	12,340.69	32,529.19	3,000.00	Aug. 9, 1833	
New Haven, Conn.	....do.....	158,143.50	113,421.64	271,565.14	25,500.00 23,032.32	June 1, 1855 Feb. 10, 1891	Extension authorized, Act Mar. 3, 1891. Working drawings completed; specification in hand.
NewLondon,Conn.	....do.....	14,600.00	14,062.53	28,662.53	3,400.00	May 18, 1833	
Do.....	Post-office and custom-house....	.....	.....	33.00	25,043.10	Mar. 13, 1893	No sketch plans or other drawings made.
Nebr. City, Nebr..	Court-house, post-office, etc.....	105,652.87	46.30	105,699.17	5,102.50	June 26, 1885	
New Orleans, La..	Custom-house and post-office....	4,221,824.40	390,767.82	4,612,592.22	.....	—— —, 1807	Site acquired from Spain and France. Extensive repairs in progress.
Do.....	Branch mint.....	327,548.55	386,652.09	714,200.64	.....	July 18, 1878	Site granted by city.
Do.....	Old marine hospital.....	498,118.55	19,972.20	518,090.84	12,000.00	Aug. 7, 1835	
Do.....	New marine hospital.....	64,409.79	51,117.24	115,527.03	35,097.00	Aug. 5, 1883	New ward water-main, and cisterns in course of construction.
Do.....	Quarantine warehouse.....	40,044.12	12,698.03	52,742.15	.....	—— —, 1827	Use of site granted by State of Louisiana.
Do.....	The "Jump".....	.....	17,235.75	17,235.75	.....	Apr. 30, 1833	Do.
Newport, R. I.....	Custom-house and post-office....	9,100.00	40,799.35	49,899.35	1,400.00	Apr. 16, 1839	
New York, N. Y..	Custom-house.....	.....	460,751.15	1,460,751.15	1,000,000.00	Apr. 29, 1865	
Do.....	Custom-house site.....	.....	.....	.....	39,138.28	.....	Site not purchased.
Do.....	Subtreasury.....	929,301.75	266,476.29	1,195,778.04	270,000.00	Jan. 13, 1833 Dec. 16, 1846	Old custom-house.
Do.....	Assay office.....	183,358.75	50,621.87	233,980.62	530,000.00	Aug. 14, 1854	
Do.....	Court-house and post-office.....	8,549,832.63	436,218.41	8,986,091.04	508,585.25	Apr. 11, 1867	Extensive repairs in progress.
Do.....	Revenue dock and barge office..	320,902.40	252,082.14	573,984.54	10,000.00	Mar. 30, 1867	
Do.....	No. 23 Pine street.....	.....	4,440.26	14,803.66	10,363.40	—— —, 1859	Total cost includes site.
Do.....	Ellis Island immigrant station..	623,910.91	.....	623,910.91	.....	.....	Government reservation.
Do.....	Surgeon's house and dispensary.	767.21	124.50	891.71	.....	.....	Built on Barge Office site.
Do.....	Appraisers' warehouse.....	.....	.....	107,091.65	505,022.48	Mar. 9, 1891	In course of construction.
Norfolk, Va.....	Custom-house and post-office....	203,903.75	60,155.88	264,059.63	13,500.00	Feb. 28, 1852	
Do.....	Court-house and post-office.....	.....	.....	2,133.96	45,398.42	Dec. 4, 1891	Sketch plans and estimates made and approved; working drawings not yet begun.
Newburg, N. Y...	Post-office.....	.....	.....	292.00	36,635.59	May 17, 1892	Sketch plans and estimates made and approved; working drawings begun.
Newberne, N. C...	Post-office, court-house, and custom-house.	.....	.....	2,168.34	6,253.40	May 8, 1891	Sketch plans in hand, nearly ready for estimates.
Ocrocoke, N. C...	Marine hospital.....	7,827.07	300.00	8,127.07	1,100.00	May 15, 1843	
Ogdensburg, N. Y.	Custom-house and post-office....	220,650.58	17,333.85	237,984.43	8,100.00	Feb. 14, 1857	
Omaha, Nebr.....	....do.....	325,006.96	19,074.69	371,081.65	.....	May 19, 1870	Site donated.
Do.....	Court-house, custom-house, and post-office.	.....	.....	133,067.76	400,000.00	May 14, 1890	In course of construction.
Oswego, N. Y.....	Custom-house and post-office....	113,977.98	30,126.51	144,104.49	12,000.00	Dec. 15, 1854	
Oxford, Miss.....	Court-house, post-office, etc.....	60,610.94	215.25	60,826.19	6,126.90	Feb. 18, 1884	
Oshkosh, Wis.....	....do.....	92,218.22	65.00	92,283.22	10,145.79	Nov. 23, 1886	
Owensboro, Ky...	Post-office, etc.....	49,525.77	1,766.05	51,291.82	215.30	June 27, 1887	Site donated.
Ottumwa, Iowa...	Post-office.....	42,263.43	134.60	42,398.03	213.44	Dec. 24, 1888	Do.
Opelousas, La....	Court-house and post-office.....	44,327.29	90.75	44,418.04	3,021.81	June 21, 1889	

Tabular Statement of Custom-houses, Court-houses, Post-offices, Marine Hospitals, etc.—Continued.

Location.	Nature of Work.	Actual Cost of Construction.	Cost of Alterations and Repairs.	Total Cost of Work to June 30, 1893.	Cost of Site.	Date of Purchase.	Remarks.
Parkersb'g, W. Va.	Court-house and post-office.....	$223,059.03	$13,320.31	$236,379.34	$17,841.40	June 23, 1873	
Paris, Tex.....	....do.....	.....	.....	33,673.60	1,596.35	May 2, 1891	Building in course of construction.
Puducah, Ky.....	Post-office, court-house, etc.....	128,032.13	2,975.80	131,007.93	7,477.30	July 31, 1880	
Paterson, N. J....	Post-office.....	.....	.....	25.90	22,260.32	Dec. 31, 1892	No sketch plans or other drawings made.
Pawtucket, R. I...	....do.....	.....	.....	10.00	24,355.84	Sept. 9, 1892	Do.
Plattsburg, N. Y..	Custom-house and post-office....	66,425.17	12,952.59	79,377.76	5,000.00	June 10, 1856	
Pensacola, Fla....	Court-house, post-office, etc.....	187,284.34	755.15	188,039.49	19,507.60	Mar. 12, 1883	
Perth Amboy, N. J.	Custom-house.....	1,374.06	.....	1,374.06	2,000.00	July 30, 1857	
Peoria, Ill.....	Post-office, court-house, etc.....	266,833.86	957.86	267,791.72	37,443.00	Oct. 13, 1882	
Petersburg, Va....	Custom-house and post-office....	84,664.88	23,624.15	108,289.03	15,000.00	Feb. 5, 1856	
Pittsburg, Pa.....	Custom-house.....	68,666.87	67,780.60	136,447.47	41,000.00	May 8, 1856	Sold Feb. 27, 1893, for $433,500.
Do.....	Court-house and post-office.....	1,610,462.15	7,375.62	1,617,837.77	347,301.30	Apr. —, 1887	$46,176.30 of cost of site donated by citizens.
Do.....	Appraisers' stores.....	.....	499.46	499.46	.....	.....	Transferred from War Department May 26, 1878.
Philadelphia, Pa..	Custom-house, etc.....	.....	157,818.39	383,818.39	225,000.00	Aug. 24, 1844	Total cost includes site (U. S. Bank).
Do.....	Post-office and court-house.....	4,623,943.49	42,816.54	4,666,760.03	1,491,200.90	Apr. 4, 1873 Mar. 12, 1875	
Do.....	United States mint (old).....	249,475.93	205,903.32	455,379.25	31,666.67	Apr. 29, 1857	
Do.....	United States mint (new).....	.....	.....	.....	6,303.59	....	Expense incident to securing site.
Do.....	Appraisers' stores.....	379,675.04	51,880.04	431,555.08	250,000.00	Mar. 2, 1857	
Do.....	Lazaretto.....	.....	9,048.60	38,287.53	.....	—— —, 1802	Total cost includes site and building.
Do.....	Marine hospital.....	1,000.00	1,250.70	2,250.70	.....	.....	Surgeon's office erected on custom-house lot, 1877.
Poughk'psie, N. Y.	Post-office.....	72,801.40	6,474.12	79,275.52	37,540.17	Sept. 1, 1883	
Portsmouth, N. H.	Custom-house and post-office....	145,116.91	57,847.81	202,964.72	19,500.00	June 28, 1857	
Portsmouth, Ohio.	Post-office.....	62,495.02	210.55	62,705.57	12,391.85	Mar. 16, 1889	
Portland, Me.....	Custom-house.....	494,981.03	18,266.07	513,247.10	40,500.00	Oct. 4, 1828 Dec. 21, 1866	
Do.....	Court-house and post-office.....	392,214.64	32,675.31	424,889.95	5,500.00	July 5, 1849	Site old custom-house.
Do.....	Marine hospital.....	83,511.35	59,249.88	142,761.23	12,446.15	Mar. 22, 1852 Feb. 25, 1869	Electric-light plant authorized Act March 3, 1891; drawings finished; specifications in hand.
Portland, Oregon.	Custom-house and post-office....	365,332.20	15,920.59	381,252.79	15,000.00	Apr. 6, 1868	
Do.....	Custom-house.....	.....	.....	702.33	160,405.80	June 3, 1892	No sketch plans or other drawings made.
Port Huron, Mich.	Custom-house and post-office....	240,703.34	8,252.35	248,955.69	5,250.00	Jan. 16, 1873	
Port Townsend, Wash.	Marine hospital.....	.....	2,722.53	20,722.53	18,000.00	Oct. 11, 1892	Total cost includes site and building; new wards authorized Act March 3, 1893; no drawings made.
Do.....	Custom-house, post-office, etc...	230,430.67	85.25	230,515.92	9,177.19	Dec. 31, 1885	Building in course of construction.
Providence, R. I..	Custom-house and post-office....	209,723.32	68,473.38	278,196.70	40,000.00	Oct. 9, 1854	
Do.....	Appraisers' stores.....	7,504.00	6,238.08	13,742.08	3,000.00	Nov. 16, 1817	
Pueblo, Colo.....	Post-office.....	.....	.....	1,437.86	1,009.86	May 24, 1892	Site donated; sketch plans made and approved, including estimates; working drawings not yet begun.
Quincy, Ill.....	Post-office, court-house, etc.....	164,325.15	234.92	164,560.07	15,633.20	Mar. 28, 1883	
Racine, Wis.....	Custom-house and post-office....	.....	.....	713.43	25,214.56	Dec. 21, 1891	No sketch plans or other drawings made.
Raleigh, N. C.....	Court-house and post-office.....	341,496.87	12,782.57	354,279.44	8,120.53	Aug. 7, 1860	
Richmond, Ky....	Post-office.....	.....	.....	8,684.44	15,010.40	Dec. 8, 1891	Building in course of construction.
Richmond, Va.....	Custom-house, etc.....	193,757.35	254,311.09	448,068.44	61,000.00	June 22, 1853	
Rockland, Me.....	....do.....	132,828.11	12,140.88	144,968.99	12,000.00	Oct. 4, 1872	
Rochester, N. Y...	Court-house, post-office, etc.....	513,440.41	5,042.10	518,482.51	75,769.68	May 1, 1883	
Rutland, Vt.....	Court-house and post-office.....	70,324.43	18,906.86	89,231.29	1,900.00	July 1, 1857 May 17, 1859	
Reading, Pa.....	Post-office.....	132,578.15	971.37	133,549.52	47,413.55	Nov. 15, 1886	

Tabular Statement of Custom-houses, Court-houses, Post-offices, Marine Hospitals, etc.—Continued.

Location.	Nature of Work.	Actual Cost of Construction.	Cost of Alterations and Repairs.	Total Cost of Work to June 30, 1893.	Cost of Site.	Date of Purchase.	Remarks.
Reidsville, N. C...	Post-office, court-house, and custom-house.	.....	.....	$6,834.41	$4,047.84	Oct. 30, 1891	Building in course of construction.
Rock Island, Ill...	Post-office.....	.....	.....	1,892.24	9,349.96	Apr. 21, 1892	No sketch plans or other drawings made.
Rockford, Ill.....	....do.....	.....	.....	5,916.44	17,822.10	Nov. 16, 1891	Building in course of construction.
Roanoke, Va.....	....do.....	.....	.....	15.00	13,233.80	Aug. 1, 1892	Sketch plans and estimates made and approved; working drawings not begun.
Rome, Ga.....	....do.....	.....	.....	6,696.74	9,178.55	Mar. 31, 1892	Do.
Santa Fe, N. Mex.	Court-house, etc.....	$64,402.91	$1,293.10	65,696.01	.....	.....	Site acquired from Mexico.
Sag Harbor, N. Y.	Custom-house.....	.....	175.00	175.00	.....	.....	Transferred from War Department, old arsenal building torn down.
St. Augustine, Fla.	Court-house and post-office.....	14,515.43	29,975.04	44,490.47	.....	—— —, 1820	Site acquired from Spain.
St. Louis, Mo.....	Custom-house and post-office....	5,686,854.68	28,265.25	5,715,119.93	368,882.65	May 23, 1874	
Do.....	Old custom-house.....	321,987.08	220,894.07	542,881.15	37,000.00	Oct. 1, 1851	Used as appraiser stores.
Do.....	Marine hospital.....	86,288.40	363,164.81	449,453.21	.....	Mar. 7, 1850	Ceded by War Department.
St. Paul, Minn....	Custom-house, etc.....	429,299.38	34,877.85	464,177.23	16,056.13	Apr. 10, 1867	
Do.....	Post-office, court-house, and custom-house.	.....	.....	28,250.11	1,058.81	June 12, 1891	Site donated; in course of erection.
St. Joseph, Mo....	Post-office.....	349,450.00	3,901.36	353,351.36	11,750.00	Jan. 6, 1883	
San Francisco, Cal.	Custom-house, etc.....	628,581.40	96,248.83	724,830.23	150,000.00	Sept. 5, 1854	
Do.....	Marine hospital.....	74,316.64	38,868.45	113,185.09	....	.....	Government reservation, new wards, etc., in course of construction.
Do.....	Old appraisers' stores.....	93,566.75	17,606.77	111,173.52	.....	.....	Do.
Do.....	New appraisers' stores.....	840,000.00	33,645.76	873,645.76	.....	.....	Do.
Do.....	Branch mint.....	2,130,512.15	8,056.98	2,138,569.13	100,000.00	Jan. 1, 1867	
Do.....	Subtreasury.....	.....	133,791.51	133,791.51	283,929.10	May 2, 1854	Remodeled old branch mint.
Do.....	Post-office, court-house. etc.....	.....	.....	1,923.47	1,054,232.71	Dec. 18, 1891	No sketch plans or other drawings made.
Sacramento, Cal..	Post-office, etc.....	.....	.....	187,262.43	40,695.97	Apr. 30, 1887	Building in course of construction.
Salem, Mass.....	Custom-house and post-office...	14,271.77	26,432.77	40,704.54	5,000.00	June 13, 1818	
Savannah, Ga.....	....do.....	149,879.56	32,729.95	188,609.51	20,725.00	July 26, 1842 Dec. 16, 1845	
Do.....	Court-house, post-office, etc.....	.....	.....	19,624.04	35,710.04	May 31, 1888 Feb. 3, 1889	Authorized to be sold, Act Jan. 21, 1891, and new site selected.
Do.....	Court-house, post-office, etc.....	.....	.....	2,572.48	55,782.04	Aug. 5, 1891	Sketch plans finished; ready for estimates; working drawings not yet made.
Sandusky, Ohio...	Custom-house and post-office....	63,987.16	23,776.04	87,763.20	11,000.00	Dec. 28, 1854	
Springfield, Ill....	Court-house and post-office.....	287,803.85	43,631.68	331,435.26	9,000.00 20,001.00	Mar. 2, 1857 Mar. 10, 1885	Additional land.
Springfield, Ohio..	Post-office.....	124,659.59	38.90	124,698.49	19,850.00	Nov. 13, 1885	
Springfield, Mass..	....do.....	130,860.66	893.93	131,754.59	18,715.00	Sept. 3, 1887	
Springfield, Mo....	Court-house and post-office.....	.....	.....	81,373.36	20,338.90	Nov. 29, 1889	Building in course of construction.
Suspension Br'ge, N. Y.	Custom-house and post-office....	.....	31,348.21	31,348.21	*6,000.00	May 25, 1867	
Syracuse, N. Y....	Post-office, court-house, etc.....	330,793.49	5,733.24	336,526.73	70,276.61	May 21, 1883	
Scranton, Pa.....	Post-office, etc.....	163,895.93	.....	163,895.93	35,484.77	Apr. 14, 1883	Do.
Shreveport, La....	Post-office, court-house, etc.....	99,434.41	5,361.69	104,796.10	10,037.15	Apr. 12, 1884	
San Antonio, Tex.	Court-house, post-office, etc.....	185,219.25	3,353.03	188,572.28	24,734.32	July 17, 1886	
Sedalia, Mo.....	Post-office.....	49,581.33	12.75	49,594.08	115.58	June 22, 1889	Site donated; completed since last report.
Statesville, N. C..	Court-house and post-office.....	72,339.77	64.13	72,403.90	4,165.52	May 4, 1889	
St. Albans, Vt....	Custom-house and post-office....	.....	.....	9,734.30	8,788.40	Apr. 12, 1892	Building in course of construction.
Saginaw, Mich....	Post-office.....	.....	.....	3,106.68	415.54	Sept. 14, 1891	Site donated; sketch plans and estimates made and approved; working drawings not yet begun.

* Building and site.

Tabular Statement of Custom-houses, Court-houses, Post-offices, Marine Hospitals, etc.—Continued.

Location.	Nature of Work.	Actual Cost of Construction.	Cost of Alterations and Repairs.	Total Cost of Work to June 30, 1893.	Cost of Site.	Date of Purchase.	Remarks.
Salina, Kans.....	Post-office.....	.....	.....	$4,209.79	$12,065.08	June 18, 1891	Sketch plans and estimates made and approved; working drawings not yet begun.
San Jose, Cal.....	Post-office, etc.....	.....	.....	88,518.15	39,454.67	Nov. 5, 1890	Building in course of construction.
Sioux City, Iowa..	Court-house, post-office, and custom-house.	.....	.....	584.29	21,464.53	Aug. 31, 1892	Working drawings finished; work to be advertised.
Sioux Falls, S. Dak.	Custom-house and post-office....	.....	.....	49,792.60	8,282.54	July 22, 1891	Building in course of construction.
Staunton, Va.. ...	Post-office.....	.....	.....	2,153.64	12,587.04	Jan. 1, 1892	Do.
Stockton, Cal.....	....do.....	.....	.....	.....	17,617.55	Mar. 19, 1892	No sketch plans or other drawings made.
Sheboygan, Wis...	Custom-house and post-office....	.....	.....	2,577.66	10,307.67	Oct. 12, 1891	Sketch plans and estimates made and approved; drawings for building half done.
South Bend, Ind..	Post-office.....	.....	.....	1,724.18	15,194.82	Oct. 24, 1891	Sketch plans and estimates made and approved; working drawings not yet begun.
Tallahassee, Fla...	Court-house and post-office.....	.....	.....	26,021.91	4,116.40	Jan. 17, 1891	Building in course of construction.
Terre Haute, Ind..	Post-office, etc.....	$164,966.41	$558.10	165,524.51	20,172.33	Sept. 14, 1883	
Texarkana, Ark., and Tex.	Court-house and post-office.....	101,433.96	21.00	101,454.96	8,175.80	Mar. 31, 1889	Completed since last report.
Toledo, Ohio.....	Custom-house, court-house, etc.	375,641.17	1,508.95	377,150.12	12,000.00 53,251.70	Feb. 10, 1855 Jan. 15, 1881	
Troy, N. Y.....	Post-office, court-house, etc.....	.....	.....	245,877.37	99,981.54	Jan. 9, 1886	Building in course of construction
Tyler, Tex.....	Court-house and post-office.....	50,008.47	1,069.84	51,078.31	6,781.63	Sept. 1, 1885	
Trenton, N. J.....	....do.....	326,382.26	14,104.68	340,486.94	82,375.93	May 14, 1872	
Topeka, Kans.....	....do.....	286,058.24	9,618.18	295,676.42	10,000.00	Aug. 16, 1875	
Taunton, Mass....	Post-office.....	.....	.....	684.00	243.86	July 8, 1891	Site donated; sketch plans and estimates made and approved; working drawings not yet begun.
Utica, N. Y.....	Court-house and post-office.....	252,307.30	7,861.78	260,169.08	161,192.25	Feb. 10, 1874	
Vanceboro, Me....	Customs office.....	4,942.29	1,055.41	5,996.70	.....	May 1, 1884	Site leased from Maine Central Railroad at $1,200 per annum.
Vineyard Haven, Mass.	Marine hospital.....	.....	6,431.52	6,431.52	1,220.75	June 7, 1892	Work advertised; bids rejected; modified drawings necessary.
Vicksburg, Miss...	Court-house, post-office, and custom-house.	99,936.50	71.25	100,007.75	9,190.08	Mar. 20, 1889	Building in course of construction.
Waco, Tex.....	Court-house, post-office, etc.....	98,414.17	474.20	98,888.37	10,272.00	Mar. 30, 1885	
Waldoboro, Me....	Custom-house and post-office....	22,424.68	3,997.57	26,422.25	2,000.00	Nov. 29, 1852	
Washington, D.C..	Treasury building.....	6,166,141.40	727,579.26	6,893,720.66	.....	.....	Government reservation.
Do.....	Bureau of Engraving and Printing.	330,493.00	89,687.28	420,180.28	54,357.25	June 25, 1878 July 1, 1880 Apr. 22, 1886 July 13, 1891	Boiler plant in course of construction.
Do.....	Winder Building.....	.....	100.00	100.00	.....	.....	Transferred from War Department.
Do.....	Building for Supervising Architect.	24,774.51	.....	24,774.51	.....	.....	In south court-yard of Treasury building.
Do.....	Building southwest corner B and New Jersey avenue SE.	.....	4,560.25	4,560.25	275,000.00	Mar. 5, 1891	Butler house, occupied by Coast Survey and Marine Hospital Service.
Do.....	Building adjoining building southwest corner B and New Jersey avenue SE.	.....	.....	.....	155,000.00	Aug. 11, 1891	Richards property, occupied by Coast Survey.
Do.....	Building northwest corner B and New Jersey avenue NW.	.....	.....	.....	138,000.00	Apr. 20, 1891	Maltby House, for use of Congress and the executive departments.
Do.....	Post-office.....	.....	.....	138,258.31	655,490.77	July 11, 1891	Building in course of construction.
Watertown, N. Y..	....do.....	59,823.67	157.40	59,981.07	15,042.81	Apr. 15, 1890	
Wheeling, W. Va..	Custom-house, etc.....	96,618.64	57,919.33	154,537.97	20,500.00	Sept. 7, 1855	

Tabular Statement of Custom-houses, Court-houses, Post-offices, Marine Hospitals, etc.—Continued.

Location.	Nature of Work.	Actual Cost of Construction.	Cost of Alterations and Repairs.	Total Cost of Work to June 30, 1893.	Cost of Site.	Date of Purchase.	Remarks
Wilmington, Del..	Custom-house and post-office....	$39,569.34	$27,227.35	$66,796.69	$3,500.00	May 29, 1853	
Do.....	Court-house and post-office.....	.....	.....	58,877.90	30,660.35	Mar. 2, 1889	Building in course of construction.
Wilmington, N. C.	Custom-house and post-office....	40,000.00	10,266.63	50,266.63	15,000.00	Mar. 19, 1819 May 17, 1845	
Do.....	Marine hospital.....	37,397.44	13,268.94	50,666.38	6,500.00	Mar. 17, 1857	Act Mar. 3, 1893, authorizing sewer connections and water tanks; no drawings made.
Do.....	Wharf and warehouse.....	.....	1,915.00	1,915.00	*25,118.25	Feb. 28, 1885	For use of Revenue Marine and Customs Service.
Do.....	Post-office, custom-house, etc...	156,510.36	390.61	156,900.97	40,399.80	July 8, 1887	
Windsor, Vt.....	Court-house and post-office.....	71,347.32	22,708.70	94,056.02	4,700.00	Mar. 14, 1857	
Williamsport, Pa..	Court-house, post-office, etc.....	176,383.08	102.97	176,486.05	45,774.07	Sept. 25, 1884 June 1, 1887	
Winona, Minn....	....do.....	144,580.72	132.50	144,713.22	15,350.98	Apr. 6, 1886	
Wichita, Kans....	Post-office, court-house, etc.....	206,208.27	545.96	206,754.23	1,560.98	Mar. 14, 1886	
Wiscasset, Me....	Custom-house and post-office....	30,457.25	9,089.48	39,546.73	1,800.00	June 20, 1868	
Worcester, Mass..	Post-office, etc.....	.....	.....	68,556.98	75,377.35	Sept. 1, 1887	Building in course of construction.
York, Pa.....	Post-office.....	.....	.....	14,856.50	24,024.20	Apr. 17, 1891	Do.
Youngstown, Ohio	....do.....	.....	.....	923.02	13,203.92	Nov. 28, 1891	Sketch plans and estimates made and approved; working drawings begun.

* Building and site.

List of Contracts Existing in the Office of the Supervising Architect, September 30, 1893.

Location.	Designation.	No.	Date.	Name of Contractor.	Nature of Work.	Price.
Angel Island, San Francisco, Cal.	Quarantine station.....	306A	Apr. 3, 1893	J. H. McKay and R. McCann.	Erection and completion hospital and attendant's buildings.	$10,200.00
Do.....	....do.....	307A	....do.....	Edward Owens.....	Erection and completion laundry building and machinery.	5,243.70
Ashland, Wis.....	Post-office.....	245A	Aug. 15, 1892	Foster & Smith.....	Erection and completion, except plumbing and heating apparatus.	72,730.00
Atchison, Kans.....	....do.....	358A	Sept. 28, 1893	Saml. I. Pope & Co...	Heating and ventilating apparatus.....	6,150.00
Do.....	....do.....	234A	June 24, 1892	Geo. H. Evans & Co..	Erection and completion, except heating apparatus....	60,878.17
Augusta, Ga.....	Court-house and post-office.....	126A	Mar. 24, 1891	Blake & Williams.....	Steam-heating and ventilating apparatus.....	7,290.00
Aurora, Ill.....	Post-office.....	313A	Apr. 19, 1893	Chas. W. Gindele.....	Basement and area walls, first-floor beams, iron columns, etc.	8,668.00
Bay City, Mich.....	Court-house, post-office, and custom-house.	279A	Jan. 7, 1893	Henry Shenk.....	Interior finish.....	34,436.00
Do.....	Court-house, post-office, and custom-house.	287A	Feb. 2, 1893	Sproul & McGurrin...	Heating and ventilating apparatus.....	5,717.00
Do.....	Court-house, post-office, and custom-house.	349A	Aug, 24, 1893	Henry Fox.....	Approaches.....	6,428.62
Beatrice, Nebr.....	Post-office.....	214A	Apr. 15, 1892	John A. Dahlgren....	Erection and completion, except general excavation and heating apparatus.	37,497.00
Birmingham, Ala.....	Court-house and post-office.....	261A	Oct. 29, 1892	Robert Clark.....	Heating and ventilating apparatus, etc.....	10,200.00
Do.....	....do.....	222A	Apr. 14, 1892	Buena Vista Plumbing & House Heating Co.	Plumbing and gas-piping, etc.....	7,735.00
Do.....	....do.....	211A	Mar. 19, 1892	Michael P. Scully.....	Interior finish, etc.....	54,175.00

List of Contracts Existing in the Office of the Supervising Architect, September 30, 1893—Continued.

Location.	Designation.	No.	Date.	Name of Contractor.	Nature of Work.	Price.
Burlington, Iowa.....	Post-office.....	295A	Mar. 3, 1893	Chas. W. Gindele....	Iron and wood floor, ceiling and roof construction, and roof covering for the superstructure.	$31,060.00
Do.....	Post-office.....	270A	Dec. 5, 1892	Minnesota Stone Co..	Trench excavation, foundations, cut-stone work and brickwork of basement and area walls, basement columns, first-floor beams, etc.	10,239.00
Boston, Mass.....	Post-office and sub-treasury.....	360A	Sept. 29, 1893	Lynch & Woodward..	New steam boilers.....	17,545.00
Cairo, Ill.....	Marine hospital.....	332A	June 24, 1893	John Madden.....	Miscellaneous repairs, painting, etc.....	7,374.00
Camp Low, Sandy Hook, N. J.	Quarantine station.....	316A	May 10, 1893	Danl. Cary.....	Steam disinfecting plant.....	9,985.00
Canton, Ohio.....	Post-office.....	181A	Oct. 31, 1891	Jacob J. Brumbaugh..	Trench excavation, concrete foundation, cut-stone work and brickwork, iron and wood floor, roof construction, etc.	43,319.00
Cedar Rapids, Iowa...	....do.....	292A	Feb. 27, 1893	A. H. Connor & Co...	Cut-stone and brickwork, iron and wood floor, ceiling and roof construction, roof covering, etc.	27,750.00
Charleston, S. C.....	Post-office, court-house, etc.....	152A	July 11, 1891	John J. Harrington...	Iron floor, ceiling and roof construction, copper work, etc.	50,490.00
Do.....	Post-office, court-house, etc.....	23A	Jan. 13, 1890	D. A. J. Sullivan.....	Stone and brickwork, etc.....	134,000.00
Chattanooga, Tenn....	Court-house and post-office.....	277A	Dec. 22, 1892	Blake & Williams.....	Heating and ventilating apparatus.....	6,598.00
Chester, Pa.....	Post-office.....	322A	June 12, 1893	Asher Bassford.....	Trench excavation, foundation, basement, and area walls, basement columns, first-floor beams, etc.	10,699.00
Chicago, Ill.....	Custom-house and sub-treasury.	343A	Aug. 16, 1893	Farrell & Merker.....	Heating apparatus.....	6,975.00
Do.....	....do.....	317A	May 11, 1893	E. F. Gobel.....	Certain repairs, new mail elevator.....	5,437.00
Do.....	....do.....	312A	Apr. 15, 1893	Benj. Hyde.....	Erection and completion (extension).....	60,980.00
Do.....	....do.....	336A	July 21, 1893	....do.....	Changes and additions.....	5,640.00
Do.....	Custom-house and sub-treasury (extension).	323A	June 19, 1893	L. L. Leach & Sons...	Post-office screen, and miscellaneous repairs.....	9,997.00
Do.....	Government building, World's Columbian Exposition.	175A	Oct. 8, 1891	Northwestern Contracting Co.	Roof covering, tin work, galvanized-iron work, etc....	104,000.00
Do.....	....do.....	291A	Feb. 16, 1893	John F. Reese.....	Partitions.....	7,000.00
Do.....	....do.....	201A	Jan. 29, 1892	Edward Johnson.....	Fifty-three plaster models.....	6,437.00
Do.....	World's Columbian Exposition, Indian Industrial School.	281A	Jan. 11, 1893	John Waline.....	Erection and completion, including plumbing and front porch.	7,300.00
Do.....	World's Columbian Exposition, Government building.	278A	Jan. 13, 1893	Phillipson Brothers...	Decorative painting.....	14,944.00
Do.....	Marine hospital.....	343½A	Aug. 18, 1893	Geo. F. Bodwell.....	Miscellaneous repairs.....	8,936.00
Do.....	Appraisers' stores.....	29A	Dec. 18, 1889	Clark, Bennett & Co..	Steel shutters.....	5,040.00
Columbus, Ga.....	Post-office.....	296A	Mar. 6, 1893	Frank Baldwin.....	Excavation, foundations, basement and area walls, basement columns, and first-floor construction.	13,644.00
Dallas, Tex.....	Court-house and post-office.....	275A	Dec. 15, 1892	Brown & Dabney..,..	Erection and completion, except heating apparatus and plumbing.	97,750.00
Danville, Ill.....	Post-office, etc.....	290A	Feb. 3, 1893	Chas. F. Schultz & Co.	Cut-stone and brickwork, iron and wood floor, ceiling and roof construction, roof covering, etc.	29,500.00
Denver, Colo.....	Court-house, post-office, etc.....	217A	Apr. 16, 1892	Saml. I. Pope & Co...	Heating and ventilating apparatus.....	21,740.00
Do.....	Court-house, post-office, etc.....	168A	Oct. 1, 1891	John Moore & Co.....	Joinery, wood floor, etc.....	44,450.00
Detroit, Mich.....	Court-house, post-office, etc.....	223A	May 21, 1892	Benj. Hyde.....	Iron columns, iron floor, ceiling, etc.....	51,980.00
Do.....	....do.....	185A	Oct. 31, 1891	E. F. Gobel.....	Stone and brick masonry of the superstructure.....	247,311.00
Diamond Point, Port Townsend, Wash.	Quarantine station.....	329A	June 24, 1893	Chas. Sayre.....	Wharf, buildings, etc., including cast-iron pile casings.	28,546.00
Duluth, Minn.....	Court-house, custom-house, and post-office.	318A	May 15, 1893	Allan Black & Co....	Heating and ventilating apparatus.....	12,745.00
Do.....	....do.....	355A	Sept. 30, 1893	L. L. Leach & Sons...	Interior finish, plumbing, etc.....	51,890.00

List of Contracts Existing in the Office of the Supervising Architect, September 30, 1893—Continued.

Location.	Designation.	No.	Date.	Name of Contractor.	Nature of Work.	Price.
El Paso, Tex	Post-office and court-house	259A	Sept. 19, 1893	Chafer & Becker	Low-pressure, return circulation, steam-heating and ventilating apparatus.	$8,910.00
Erie, Pa	Court-house, post-office, etc	283A	Feb. 10, 1893	Eaton & Prince Co	Passenger elevator	6,800.00
Fargo, N. Dak	Post-office and court-house	353A	Sept. 9, 1893	Chas. W. Gindele	Excavation, foundations, etc	12,500.00
Fishermans Isl'd, near Cape Charles, Va.	Quarantine station	335A	July 17, 1893	I. H. Hathaway & Co.	Kitchen, laundry, etc., building, gangway, wharf and building, etc.	13,995.00
Do	...do	348A	Aug. 21, 1893	Wm. H. Virden	Detention barracks, cholera suspects	7,700.00
Fort Dodge, Iowa	Post-office	243A	Sept. 5, 1892	Groves & Hackett	Excavation, foundation, stone and brickwork, iron and wood floor, roof construction, roof covering, etc., approaches, etc., plaster models.	38,492.00
Fort Worth, Tex	....do	325A	June 23, 1893	Geo. H. Evans	Cut-stone and brickwork, iron and wood floor, ceiling and roof construction, roof covering, skylight, etc.	58,356.00
Fremont, Nebr	....do	276A	Dec. 17, 1892	Wm. P. White	Trench excavation, foundation, cut-stone work and brickwork.	26,883.00
Galesburg, Ill	....do	299A	Mar. 9, 1893	Valentine Jobst	Erection and completion, except heating apparatus and approaches.	41,277.00
Greenville, S. C	Court-house, post-office, etc	50A	June 16, 1890	Jas. R. Lawrence	Erecting and completing	76,290.00
Do	....do	253A	Oct. 1, 1892	Blake & Williams	Low-pressure, return-circulation, steam-heating apparatus.	5,984.00
Helena, Ark	Court-house and post-office	105A	Dec. 9, 1890	James E. Tinsley	Erection and completion, except heating and approaches.	45,795.00
Hoboken, N. J	Post-office	180A	Oct. 19, 1893	Johnson & Byrens	Erection and completion, except heating apparatus	37,900.00
Houlton, Me	Custom-house and post-office	324A	June 20, 1893	M. C. Foster & Son	Erection and completion, except heating apparatus, and including approaches.	45,000.00
Huntsville, Ala	Court-house, post-office, etc	100A	Dec. 2, 1890	John Lyon	Heating and ventilating apparatus	5,927.00
Jackson, Mich	Post-office	196A	Jan. 11, 1892	Robert M. Jack & Son	Excavation, concrete foundations, stone and brickwork, iron and wood floor, roof construction, roof covering, etc.	40,300.00
Jacksonville, Fla	Post-office, custom-house, etc	213A	Apr. 29, 1892	Miles & Bradt	Wood and iron floor and roof construction and roof covering, etc.	14,584.00
Do	....do	220A	Apr. 8, 1892	W. C. Green Co	Erection and completion, ready for interior finish	134,821.00
Kansas City, Mo	Post-office and court-house	298A	Mar. 9, 1893	Orlando J. King	Trench and pit excavation, cut-stone and brickwork of basement walls, etc.	14,557.00
Do	Post-office and court-house	338A	July 25, 1893	Brown-Ketchum Iron Works.	Basement columns, first-floor ironwork, I beams, lintels, stone bearing-blocks.	10,878.85
Do	....do	274A	Dec. 20, 1892	Patrick Keating	Excavation, sewer connection, etc	6,480.00
Knoxville, Tenn	Court-house and post-office	328A	June 26, 1893	Eaton & Prince Co	Passenger elevator, etc	9,220.00
Lafayette, Ind	Post-office	215A	Apr. 23, 1892	Boseker & Maellering	Erection and completion, except heating apparatus	48,874.00
Lansing, Mich	....do	194A	Dec. 22, 1891	Nelson M. Bassett	Erection and completion	68,356.00
Lewiston, Me	....do	303A	Mar. 30, 1893	M. C. Foster & Son	Excavation, stone and brick masonry, cut-stone and brickwork, wood floor, ceiling and roof construction and roof covering.	36,000.00
Louisville, Ky	Court-house and post-office	230A	June 3, 1892	Crane Elevator Co	Passenger elevator and mail lift	14,597.00
Lowell, Mass	Post-office	225A	May 28, 1892	Staples Brothers	Cut-stone and brickwork, iron and wood floor, etc	79,396.00
Mankato, Minn	Court-house and post-office	265A	Nov. 19, 1892	W. B. Craig	Trench excavation, foundations, basement and area walls, basement columns, first-floor beams.	10,999.00
Mary Island and Sand Point, Alaska	Custom-house	148A	June 17, 1891	Daniel McFee	Erection and completion	14,600.00
Martinsburg, W. Va	Court-house and post-office	271A	Dec. 9, 1892	R. M. Jack & Co	Erection and completion, except plumbing, heating apparatus, and approaches.	46,000.00
Milwaukee, Wis	Post-office, court-house, and custom-house.	319A	May 15, 1893	Wm. Bayley & Sons	Basement columns, first-floor beams, girders, etc	13,750.00

List of Contracts Existing in the Office of the Supervising Architect, September 30, 1893—Continued.

Location.	Designation.	No.	Date.	Name of Contractor.	Nature of Work.	Price.
Milwaukee, Wis.....	Post-office, court-house, and custom-house.	284A	Feb. 1, 1893	Thomas P. Bentley...	Trench excavation, concrete and stone footings, cut-stone and brickwork, basement and area walls.	$114,505.00
Newark, N. J.....	Custom-house and post-office....	228A	June 4, 1892	Johnson & Byrens....	Cut-stone work and brickwork, etc.....	114,500.00
Do.....	....do.....	216A	Apr. 11, 1892	Tacony Iron and Metal Co.....	Cast-iron columns, steel and iron floor, ceiling, roof construction, skylight roof, etc.	20,985.00
New York, N. Y.....	Appraisers' warehouse.....	267A	Nov. 19, 1892	Michael Giblin.....	Erection and completion, except plumbing and gas-piping, heating apparatus, etc., electric-light wiring, and approaches.	589,502.00
Do.....	Court-house and post-office.....	252A	Sept. 7, 1892	Gillis & Geoghegan..	New steam and return risers, removal of radiators.....	14,397.00
Omaha, Nebr.....	Court-house, custom-house, and post-office.	224A	May 28, 1892	Paxton & Vierling Iron Works.	Iron beams and girders in basement and first floor, etc.	11,370.00
Do.....	....do.....	206	Feb. 18, 1892	Orlando J. King.....	Trench excavation, concrete and stone foundations, cut-stone and brickwork of basement and area walls, etc.	91,046.00
Paris, Tex.....	Court-house and post-office.....	269A	Dec. 2, 1892	Anderson Brothers...	Trench excavation, foundations, cut-stone work and brickwork, iron and wood floor, ceiling and roof construction, roof covering, etc.	43,979.00
Pittsburg, Pa.....	....do.....	99A	Nov. 24, 1890	Saml. I. Pope & Co...	Heating and ventilating apparatus and temporary heating.	46,850.00
Port Townsend, Wash.	Custom-house, post-office, etc...	260A	Sept. 9, 1892	The Bailey Steam Heating Co.	Low-pressure, return-circulation, steam-heating, and ventilating apparatus.	10,384.00
Reidsville, N. C.....	Post-office, court-house, and custom-house.	315A	Apr. 26, 1893	Brown & Garber.....	Erection and completion.....	12,195.76
Richmond, Ky.....	Post-office, etc.....	346A	Aug. 19, 1893	Chas. W. Gindele....	Stone and brickwork of first story.....	11,512.00
Sacramento, Cal.....	....do.....	356A	Sept. 27, 1893	John Lyon.....	Heating and ventilating apparatus.....	8,889.35
Do.....	....do.....	310A	Apr. 8, 1893	Silas Carl.....	Interior finish.....	45,410.00
Do.....	....do.....	144A	June 11, 1891	Kreuzberger & Harvie	Superstructure.....	115,090.00
Do.....	....do.....	337A	July 22, 1893	Frank Lyman.....	Plumbing and gas-piping.....	6,858.00
San Diego, Cal.....	Quarantine station.....	246A	Aug. 22, 1892	Coronado Foundry & Machine Co	Erection and completion.....	21,699.11
Scranton, Pa.....	Post-office, etc.....	354A	Sept. 20, 1893	B. E. Leonard.....	Heating and ventilating apparatus.....	10,795.00
Do.....	....do.....	300A	Mar. 11, 1893	A. M. Walkup.....	Interior finish and plumbing, etc.....	44,083.74
Sioux Falls, S. Dak....	Court-house and post-office.....	258A	Sept. 15, 1892	C. W. Hubbard & Co.	Trench excavation, concrete foundations, cut-stone and brickwork, iron and wood floor and roof construction, roof covering, etc.	96,264.00
Sitka, Alaska.....	Baranoff Castle and Barracks...	304A	Mar. 30, 1893	Chas. W. Young.....	Repairs.....	12,675.00
Springfield, Ill.....	Court-house and post-office.....	331A	June 30, 1893	Robert Clark.....	Heating apparatus, etc.....	7,400.00
Springfield, Mo.....	....do.....	334A	July 18, 1893	J. E. Shover.....	Interior finish and plumbing.....	27,927.00
Do.....	....do.....	320A	May 19, 1893	Robert Clark.....	Heating and ventilating apparatus.....	5,900.00
Do.....	....do.....	197A	Jan. 16, 1892	Wm. H. Sternberg....	Cut-stone and brickwork, iron and wood floors, roof construction, and roof covering.	55,913.00
Statesville, N. C.....	....do.....	249A	Sept. 9, 1892	Robert Clark.....	Return circulation, steam-heating and ventilating apparatus.	6,000.00
St. Albans, Vt.....	Custom-house and post-office....	301A	Mar. 11, 1893	D. & J. Betts.....	Excavation, foundations, stone and brickwork, floor and roof construction and roof covering, etc.	12,375.00
St. Louis, Mo.....	....do.....	311A	Apr. 8, 1893	The Macneale & Urban Safe & Lock Co.	Lining silver vault.....	6,820.00
Do.....	Appraisers' stores.....	122A	Feb. 26, 1891	John F. Dalton.....	Steam-heating apparatus, steam-boiler, boiler-house, coal vault, etc.	18,541.00
St. Paul, Minn.....	Post-office, court-house, and custom-house.	288A	Feb. 2, 1893	J. D. Moran M'f'g & Construction Co.	Excavation and stone masonry of sub-basement and coal vault.	20,188.00
Do.....	....do.....	309A	Apr. 4, 1893	Hennessey Brothers & Cox.	Cut-stone and brickwork of basement and superstructure.	287,800.00

List of Contracts Existing in the Office of the Supervising Architect, September 30, 1893—Continued.

Location.	Designation.	No.	Date.	Name of Contractor.	Nature of Work.	Price.
St. Paul, Minn.....	Post-office, court-house, and custom-house.	351A	Aug. 28, 1893	Northwestern Wheel and Foundry Co.....	Iron columns, sub-basement, basement, etc.....	$10,122.70
Staunton, Va.....	Post-office.....	345A	Aug. 17, 1893	Frank Baldwin.....	Basement, superstructure, etc.....	34,229.00
Tallahassee, Fla.....	Court-house and post-office.....	286A	Feb. 6, 1893	S. S. Leonard.....	Cut-stone and brickwork of the superstructure; roof covering, etc.	26,999.00
Trenton, N. J.....	....do.....	327A	June 24, 1893	Otis Brothers & Co...	Electric passenger elevator.....	6,950.00
Troy, N. Y.....	Post-office, court-house, etc.....	305A	Apr. 1, 1893	The Lee Fire-proof Construction Co.	Floor arches, concrete filling, etc.....	9,966.00
Do.....	....do.....	326A	June 24, 1893	H. & T. Mellon.....	Iron furring, lathing, and plastering, and plaster models.	9,996.00
Do.....	....do.....	268A	Dec. 2, 1892	John J. Harrington...	Roof sheathing, slating, gutter-work, roof skylight, down and drain pipes, etc.	10,790.00
Do.....	....do.....	187A	Nov. 27, 1891	Fred J. Myers Manufacturing Co.	Iron floor, ceiling and roof construction, iron columns, etc.	26,000.00
Do.....	....do.....	350A	Aug. 26, 1893	Mulligan & Schermerhorn.	Plumbing and gas-piping.....	5,500.00
Do.....	....do.....	339A	July 28, 1893	Martin Murray.....	Approaches.....	5,859.00
Various cities.....	Government buildings.....	347A	Aug. 22, 1893	Yale & Towne Manufacturing Co.	Post-office lock-boxes, drawers, etc.....	(*)
Do.....	United States public buildings..	158A	July 31, 1891	....do.....	Post-office lock-boxes.....	(*)
Do.....	....do.....	71A	Aug. 22, 1890	....do.....	Post-office lock-boxes, etc.....	(*)
Do.....	Public buildings.....	256A	Oct. 19, 1892	....do.....	....do.....	10,000.00
Vicksburg, Miss.....	Court-house, post-office, and custom-house.	248A	Sept. 8, 1892	Robert Clark.....	Low-pressure, return-circulation, steam-heating and ventilating apparatus.	5,500.00
Washington, D. C.....	Post-office.....	344A	Aug. 10, 1893	John Peirce.....	Steel and iron columns, etc.....	57,790.00
Do.....	....do.....	294A	Mar. 2, 1893	....do.....	Cut-stone and brickwork, etc., basement and area walls.	837,000.00
Do.....	....do.....	236A	June 30, 1892	W. B. Brooks, Jr.....	Trench and pit excavation and piling for foundations..	†39,993.00
Do.....	Bureau of Engraving and Printing.	352A	Aug. 30, 1893	Campbell & Zell Co...	New boiler-house.....	24,849.00
Watertown, N. Y.....	Post-office.....	86A	Oct. 15, 1890	Patrick Phillips.....	Erection and completion, except heating apparatus....	52,065.00
Wilmington, Del.....	Court-house, post-office, etc.....	242A	Aug. 16, 1892	A. S. Reed & Bro....	Stone and brickwork, roof covering, etc., of superstructure, including approaches.	111,710.00
Do.....	....do.....	244A	Aug. 31, 1892	Tacony Iron and Metal Co.	Iron columns, steel floor, ceiling and roof construction, etc.	15,686.00
Wilmington, N. C.....	Post-office and custom-house....	72A	Aug. 21, 1890	P. Linehan & Sons....	Approaches.....	10,842.00
Worcester, Mass.....	Post-office, etc.....	272A	Dec. 5, 1892	Vermont Marble Co..	Stone and brickwork of the superstructure.....	130,602.00
Do.....	....do.....	342A	Aug. 7, 1893	Benner & Opdyke....	Constructive steel and iron work.....	17,983.00
World's Columbian Exposition.	U. S. Army Hospital building...	263A	Nov. 1, 1892	John Waline.....	Hospital building.....	9,195.00
York, Pa.....	Post-office.....	333A	July 8, 1893	Asher Bassford.....	Cut-stone and brickwork, iron and wood floor, ceiling and roof construction, roof covering, etc., of the superstructure.	21,934.00

* Specified rates.

† And rates.

CHAPTER VI.

TREASURY DEPARTMENT, LIFE-SAVING SERVICE: LAWS AND REGULATIONS.

Organization—General Superintendent.—The life-saving service of the United States derives its present form of organization from a series of laws practically completed in the Act of June 18, 1878. It is a bureau of the Treasury Department, and is under the control of the Secretary of the Treasury. The immediate head is entitled General Superintendent. He is appointed by the President. Subject to the approval of the Secretary of the Treasury, he prepares and revises the regulations necessary for the control of the service, supervises the expenditures of all appropriations made for its support and maintenance; examines the accounts of the disbursements of the district superintendents; exercises supervision over the selection of sites for new stations, the establishment of which may be authorized by law, or for established stations, the removal of which may be necessary; prepares and submits to the Secretary of the Treasury estimates for the support of the service, etc., etc.

No expenditure from any appropriations for the service by any officer or employee is permitted without authority previously obtained from him. In preparing for the erection of new stations, he supervises the acquisition of land, the preparation of plans and specifications for the stations, and the obtaining of proposals and making of contracts for their construction.

Superintendents of Construction.—Two superintendents of construction, detailed by the Secretary of the Treasury from the Captains of the Revenue Marine (Sec. 4249, R. S.), have direct charge, under the General Superintendent, of all matters pertaining to the erection of new stations and the alteration and repair of old ones. Assistants are employed by them from time to time as may be necessary, by authority from the Secretary of the Treasury.

Districts.—The stations along the coast are grouped into twelve districts, and each district is under the general charge of a District Superintendent, who is also the disbursing officer and paymaster of the district. He submits from time to time to the General Superintendent estimates of the funds required for his district, and on the recommendation of the Superintendent is supplied with the requisite amounts from the several appropriations. These are deposited to his credit at a sub-treasury or authorized depositary in the usual manner, and are subject to his check, in the manner prescribed in the General Treasury Regulations.

Appropriations.—Authority to erect life-saving stations at given points is granted in special acts of Congress. The appropriations for the support of the service and for the erection of authorized stations are made in the Sundry Civil Bill. Like the appropriations for the Light-House Establishment, the appropriations for construction and repairs of stations are available until used. The remainder are fiscal-year appropriations.

Purchase of Land.—The acquisition of land for life-saving stations by purchase or donation is authorized by the Act of March 3, 1875 (page 110); by condemnation by the Act of August 1, 1888 (page 2).

The general laws and regulations governing operations under all Departments of the Government are given in Chap. I, which see. For those relating to disbursements, see page 1; to labor, page 1; for protection of persons furnishing material or labor for use on public works, see page 1; to purchase of land, page 2; to legal holidays, page 2; to purchases and contracts, page 2; to payment of checks, page 6; to method of obtaining a duplicate of a lost check, page 7; to form of checks, page 8; to payments to corporations, page 9.

PURCHASES, PROPOSALS, AND CONTRACTS.

The following extracts from the Regulations of the Life-Saving Service show the prescribed methods:

"When practicable, all purchases will be made upon proposals received after due advertisement." . . . (R. L. S. S. 180.)

OFFICIAL INFORMATION FOR BIDDERS.

Proposals for construction work will be made on blank forms, which will be furnished with the specifications and drawings.

The individual names of a firm must be signed in full to the proposal.

Bidders are required to state the time in which they agree to complete the work to be contracted for.

Each bid must be accompanied by a certified check (varying in amount with the value of the contract and fixed in each case by the General Superintendent), drawn to the order of the Secretary of the Treasury, as security that the bidder will enter into contract without delay and give such bonds as security for the faithful performance thereof as may be required if his bid be accepted.

Certified checks will be returned within two weeks to the unsuccessful bidders, and the check of the successful bidder will be returned after his contract, together with bond for the faithful performance of the terms thereof, shall be approved by the Secretary of the Treasury.

In case the successful bidder fails to enter into contract, his check will be forfeited, in the discretion of the Secretary of the Treasury.

Proposals must be inclosed in sealed envelopes and indorsed "Proposals for . . ."

The right to reject any and all bids or to waive defects, if it be deemed for the interest of the Government, is reserved. (Information for bidders.)

CONTRACTS.

Contracts are made out in the form furnished by the Department. Each is to be accompanied by a bond, in amount fixed by the General Superintendent, with good and sufficient sureties, who must procure the certificate of some United States official that they are well known to him and that he considers them good and sufficient sureties.

EMERGENCY PURCHASES.

. . . . "When authority has been given to any officer to make any purchase in open market, it will be his duty to ascertain, in writing, from at least three resyonsible dealers in the articles wanted (if there be so many in the place or in the immediate vicinity) the lowest price at which they can be furnished. The purchasing officer will then select, at the price most advantageous to the Government, the required articles of the best quality." . . . (R. L. S. S. 180.)

"Should the amount of purchases be so small that the dealers will not submit competitive bids, the supplies will be purchased at the lowest market rates obtainable." (R. L. S. S. 181.)

"Should there be reason to suspect collusion among the dealers to obtain more than a fair market price for the articles, or should the prices be exorbitant, they will be procured elsewhere at fair rates." (R. L. S. S. 182.)

PAYMENTS.

"Any check drawn by a District Superintendent upon moneys deposited to his credit must be in favor of the party by name, and payable to order (or bearer.)" (R. L. S. S. 59).

"A District Superintendent may draw his check in favor of himself (or bearer) for the amount of his own salary, or for the payment of small bills not exceeding twenty dollars each." . . . (R. L. S. S. 60.)

"In case of the death . . . . of any person having claims

against the United States on account of the service, payments are duly to be made to his legal representatives, according to the forms of law, after being duly authorized at the Department. In the case of the death of a person without property having but a small amount of pay due him, and where the taking out of letters of administration would be attended with expense to the family of the deceased, it will be the duty of the District Superintendent to make all the facts known to the General Superintendent, and receive instructions before making the payment." (R. L. S. S. 66.)

"In every case in which the Department may see fit to authorize the District Superintendent to pay any small claim to the family of a deceased person without requiring letters of administration to be taken out, it will be the duty of that officer when paying the money to take ample security in writing, to the effect that the amount may not be claimed thereafter on the ground that it was not paid to the parties legally entitled to receive it." (R. L. S. S. 67.)

"The District Superintendent before making any authorized payment to an executor or administrator will require an authenticated copy of the last will and testament of the deceased, or of the letters of administration, as the case may be, which he will file with his account." (R. L. S. S. 68.)

"In preparing pay-rolls, the date on which the service of each employee commenced and the date on which it ended will be specifically stated. . . . But the wages due an employee who is paid by the month, for fractional parts of a month, must be computed upon the basis of the actual number of days in the month or months in which the service was rendered." (R. L. S. S. 76.)

LIFE-SAVING STATIONS.

These structures are of wood, erected under contract, with sealed proposals, as stated in the preceding regulations. Each structure must be wholly finished in a substantial manner, in strict accordance with the specifications and drawings, and be clean and ready for occupation before the Government will accept and pay for it. The structures which make up a station are a dwelling, look-out, boat-house, outbuilding, flagstaff, boat incline, and such fencing or shore protection as may be required. The dwelling, boat-house, and look-out are usually in one building. The dwelling is usually one and one-half or two stories high, and the boat-house one and one-half stories high. The look-out is usually in a tower rising from the roof of the dwelling or boat-house.

The station at Milwaukee, Wisconsin, may be considered as fairly typical. It is situated at the north end of the narrow tongue of land between the south pier of the harbor entrance and the old channel of the Milwaukee River. The dwelling, boat-house, and look-out are in one L-shaped structure which faces the lake, with its back walls parallel to the river. The width of the face is 45′ 8″. The dwelling, which is in the south half, is 30′ deep. The boat-room, in the north half, is 24′ wide and 49′ 6″ deep, forming the long arm of the L. Its floor is prolonged to the river by an incline 47′ long and 24′ wide. The building is one and one half stories high, with two dormer-windows on the face. The look-out tower is over the boat-room extension, and rises so that the windows of the look-out room are above the roof ridge of the main building. The roof of the main building is extended on the face, 8′ to the front, and covers, starting from the left, a portico 7′ wide, and an enclosed space 20′ wide, in which is a pantry 7′ 6″ × 7′ 8″, and a vestibule 7′ 6″ × 10′ 8″. The ground-floor plan includes in addition to the pantry and vestibule a hall and three rooms. The hall, 6′ wide, passes through the middle of the building, from the vestibule to a back porch, 8′ wide, in rear of the hall and of the mess-room. On the left of the hall is a kitchen 10′ 5″ × 14′ 8″, and a mess-room 14′ 8″ × 15′ 11″, with a four-flue chimney between them at the inside angle. On the right of the hall is the boat-room, 22′ 10″ × 48′ 4″. For 30′ from its rear end the boat-room floor is inclined with a slope of one in ten, and at the back of the boat-room, opening on the outer incline, are two double doors, each 9′ 6″ wide. A 10′ double door is at the

front of the boat-room. A stairway, 3′ wide, leads from the hall to the second floor. On the second floor are two rooms over the kitchen and mess-room, communicating with each other and with the hall. Over the boat-room is a large room used for the crew's quarters, 22′ 10″ × 48′ 4″, with nine large closets. The look-out tower is 7′ 2″ square, and is entered by a stairway from this room. The ceiling height is 9′ throughout, but the second-floor rooms are cut off around their sides by the pitch of the roof.

The foundations of the building and of the front incline are of white-oak or rock-elm piling. The porches and the rear platform are set on cedar posts. The piles are spaced 6′ to 8′ apart, except under the chimney, where they are 3′ apart. The piles are 12″ in diameter and are driven to a depth of 9′. They are sawed off square, 1′ above the surface of the ground, and are capped with 10″ × 10″ Norway-pine timbers around the sides and under the middle of the building, and with 8″ × 10″ timbers on two other longitudinal lines and one cross line. The floor-joists of the first floor are of 3″ × 12″ white pine, spaced 16″ centres, and strongly cross-bridged. The floor-joists of the second floor are of 2″ × 12″ pine. The joists of the second floor above the boat-room rest at the middle on a 6″ × 8″ girder, suspended from the roof-trusses by wrought-iron rods. The house is framed, braced, and pinned in the best and strongest manner. The walls are sheathed, with tongued and grooved, second quality, white pine, laid diagonally. These boards are covered with best quality, resin-sized, water-proof sheathing-paper, held in place with strips of pine, 2″ wide and $\frac{1}{2}$″ thick. The facing of the walls is bevelled siding, laid 5″ to the weather. The gables are covered with white-pine shingles, laid 4$\frac{1}{2}$″ to the weather. The roofs are sheathed with boards, covered with one thickness of pine-tarred felt-paper, and with best quality, white pine shingles, laid 4″ to the weather. The floors throughout are double, except in the boat-room. The flooring of the boat-room is of first-quality rock-elm, 2″ thick and 2$\frac{1}{2}$″ wide, tongued and grooved, and blind-nailed. The rooms are lathed and plastered in the best manner, with two coats. The boat-room and look-out are sheathed with $\frac{7}{8}$″ clear white pine. The wood finish is of best quality seasoned and selected white pine. The chimneys are of brick, lined with 8″ terra-cotta flue-pipe. Lead counter-flashings are built into the chimneys. The roof flashings are of zinc.

The outbuilding is one story, 16′ × 20′ supported on cedar posts, set 4′ into the ground. It is divided into a wood and a coal-bin, an oil-room, and a closet.

The incline from the boat-room to the water is supported on three rows of piles, spaced 6′ apart longitudinally and 10′ 6″ across. Two 3″ × 12″ wales are bolted to the piles of each cross row near the top. These support ten 2″ × 12″ floor-joists which run lengthwise of the incline, and three of which are fastened to each cap with straps and spikes. The floor of the incline is of 3″ × 4″ planks, laid with 1$\frac{3}{4}$″ joints. The sides of the incline are boxed in, below the surface of the ground, with sheet-piles, strengthened by round piles. Stone ballast is placed under the floor of the incline for 25′ from the water.

The river face of the Station grounds is protected with a crib revetment, filled with stone, through which the incline passes in a cut. Outside the crib revetment is a row of fender-piles with waling-strips. On the lake face of the lot is a riprap sea-wall, with top and outer surfaces of $\frac{1}{2}$-ton blocks, and crib-stone hearting.

CHAPTER VII.

MUNICIPAL WORKS, DISTRICT OF COLUMBIA. BUILDING FOR LIBRARY OF CONGRESS. PUBLIC BUILDINGS AND GROUNDS.

DISTRICT GOVERNMENT, LAWS AND REGULATIONS.

Organization of District Government.—The present form of government of the District of Columbia was established by the Act of Congress approved June 11, 1878, and it has been but little modified by subsequent legislation. All public work in the District, carried on for or by the District, is under the charge of the Commissioners. These Commissioners are three in number, one of them being an officer of the Corps of Engineers of the Army. No term of service is fixed for the Engineer Commissioner. The two civilian Commissioners are appointed by the President of the United States, by and with the consent of the Senate, and for a term of three years. One of the Commissioners is elected President of the Board of Commissioners. Any two of the Commissioners, sitting as a Board, constitute a quorum for the transaction of business. The Engineer Commissioner is authorized by law to have as assistants three officers of the Corps of Engineers, junior to him in rank. In case of the absence of the Engineer Commissioner from the district or of his disability, the senior of the assistants present performs all of the duties of the Engineer Commissioner.

One of these assistants is charged with the supervision of all surface work, including laying out, improving, and repairing streets, alleys, and highways; construction and repair of bridges; planting and care of trees; location, construction, and repair of telegraph and telephone lines not belonging to the District or to the United States; location and construction of railroads authorized in the District. A second assistant has charge of the water department, the street-lighting service, and the inspection of gas and meters, and, as far as the District control is authorized, is in charge of gas-mains, and electrical conduits other than those for trolleys. The third is charged with the sewer department, including the operations of the plumbing inspecting force and of the permit office. This assignment of duties is subject to change at the will of the Engineer Commissioner.

In the office of the Commissioners are the following sub-offices among which the public work of the District has been divided. Each office is charged with the preparation of the plans and specifications for its portion of the work, and with the supervision and inspection of this work when approved and started. 1. Inspector of Buildings, charged with everything relating to the construction, repair, heating, lighting, ventilating, and sewering buildings. 2. Computing Engineer, charged with street and road improvements. 3. Superintendent of Streets, charged with the repair of streets and alleys. 4. Superintendent of Country Roads. 5. Superintendent of Sewers. 6. Superintendent of the Water Department. 7. Superintendent of Telegraph. 8. Superintendent of Lamps, charged with supply and erection of gas and oil lamps for street lighting. 9. Chief Engineer of Fire Department, charged with the supply of all plant for the fire department. 10. Engineer of Bridges. 11. Property Clerk, charged with the purchase of general supplies. 12. Superintendent of Property, charged with the purchase of general engineer supplies. 13. Inspector of Asphalt and Cements. 14. Superintendent of Street Cleaning. 15. Health Officer, charged with removal of garbage. 16. Inspector of Gas and Meters.

OFFICE METHODS.

Estimates and Appropriations.—The Commissioners prepare, annually, a statement showing in detail the work proposed to be under-

taken by them during the next fiscal year, with the estimated cost. This is submitted to the Secretary of the Treasury for his examination and approval. After examination, the Secretary returns the estimates with his comments to the Commissioners, who forward all to Congress. Congress then approves all or a portion of the estimates and appropriates 50 per cent of the total sum approved. The remaining 50 per cent is obtained by taxation in the District.

The Commissioners are forbidden to incur any liabilities other than or in excess of those authorized by Congress. Balances of the appropriations remaining unexpended at the end of two years from the close of the fiscal year for which such appropriations were made are covered into the Treasury, one half to the credit of the United States and one half to the credit of the general fund of the District.

Advertisements.—A work having been authorized and the funds having become available, advertisements for proposals and specifications are prepared in the proper sub-office. They are then submitted to the Board of Commissioners, and, when approved by them, are sent out. The Commissioners are authorized to make separate contracts for materials and for labor.

When the total cost of any proposed work does not exceed $1000, it must be advertised in one newspaper in Washington. If it exceed $5000, the advertisement must be published also for one week in one newspaper in New York, Philadelphia, and Baltimore, respectively. Advertisements for proposals for buildings need be published only in a paper in the District of Columbia for one week.

Proposals.—Proposals are opened in the presence of any one desiring to attend, and are publicly read. At least one Commissioner is present, and if possible, all. The proposals are then referred to the office in which they were prepared, where the bids are examined and tabulated. After this they are returned to the Board with remarks and recommendations from the chief of the office. The Commissioners then consider the bids and make the award. The law prescribes that the lowest responsible proposals shall be accepted, but further prescribes that the Commissioners have the right to reject all the proposals. It is further prescribed that work which can be done under a single contract shall not be subdivided so as to reduce the amount of the contract to less than $1000. Contracts for the construction, improvement, alteration, or repair of the streets, avenues, highways, alleys, gutters, sewers, and for all work of like character, must be made and entered into only by and with the official unanimous consent of the Commissioners.

Contracts.—The contracts are drawn up and submitted to the Commissioners and to the District Attorney for the District, for approval, and if correct are signed by the Commissioners. The law prescribes that the contractors shall keep new pavements or other new works in repair for a term of five years from the date of the completion of their contracts. Ten per centum of the cost of all new works must be retained as an additional security and a guarantee fund to keep the same in repair for this term of years. The Treasurer of the United States, as Commissioner of the sinking fund of the District, may in his discretion retain such funds without interest, or invest them in any class of United States or District of Columbia bonds, at the request and at the risk of the contractor, whenever the sum retained on any contract shall reach the sum of $100 or more. Any sum less than $100 shall be retained without interest.

Bonds.—Good and sufficient bonds to the United States, in a penal sum not less than the amount of the contract, with sureties to be approved by the Commissioners of the District, are required from all contractors, guaranteeing that the terms of their contracts shall be strictly and faithfully performed to the satisfaction of and acceptance by said Commissioners. Neither of the said Commissioners nor any officer whatsoever of the District can be accepted as surety on any bond required to be given to the District. Nor shall any contractor be accepted as surety for any officer or other contractor in the District.

OFFICIAL INSTRUCTIONS FOR BIDDERS.

LABOR—INSTRUCTIONS AND STIPULATIONS.

"1. These *instructions* and *stipulations* are part of the specifications. They will be strictly enforced.

"2. Proposals will be placed in a *sealed envelope*, so marked as to indicate its contents without being opened. This envelope will be placed in another addressed to the Commissioners of the District of Columbia, Washington, D. C.

"3. *Proposals* forwarded otherwise than by mail must be *delivered* to the Secretary of the Board.

"4. Proposals must be signed by the bidder submitting them with his *signature* in full. When a firm is a bidder, the member of the firm or agent who signs the firm name to the proposal shall state in addition the names of all the individuals composing the firm. Any one signing the proposal as the agent of another, or of others, must file with it legal evidence of his authority so to do.

"5. The place of residence of each bidder, with his *post-office address*, county and State, must be given after his signature, which must be written in full.

"6. Each bidder will submit a *statement* indicating what work he has done of a similar nature to that proposed in these specifications, and will also give references which will enable the Commissioners to judge of his skill and business standing.

"7. All *prices* must be written in *words* as well as expressed in figures.

"8. Each bidder will be required to deposit with the Collector of Taxes of the District of Columbia, to the credit of the Commissioners of the District of Columbia, a sum determined as set forth below, unless otherwise stated, as a guarantee that he will enter into the contract, if awarded to him, according to the terms of his bid, within ten days after notification of the award. The receipt of the Collector must be enclosed with each bid. The receipts will be forwarded to the Collector after the award of the contracts, with instructions to refund the money deposited to the unsuccessful bidders, upon application, and to each contractor after the execution of the contract.

"The amount thus required to be deposited is as follows, viz.:

"With proposals involving a total of $10,000 or less, five hundred dollars ($500).

"Between $10,000 and $25,000, one thousand dollars ($1000).

"Between $25,000 and 50,000, two thousand dollars ($2000).

"Between $50,000 and $75,000, three thousand dollars ($3000).

"Between $75,000 and $100,000, four thousand dollars ($4000).

"$100.000 or more, five thousand dollars ($5000).

"9. Alterations by erasures or interlineations must be explained or noted in the proposal over the signature of the bidder.

"10. If a bidder wishes to withdraw his proposal, he may do so before the time fixed for the opening, without prejudice to himself, by communicating his purpose in writing to the Commissioners, and when his proposal is reached it shall be handed to him or his authorized agent unread.

"11. Reasonable grounds for supposing that any bidder is interested in more than one proposal for the same item will cause the rejection of all proposals in which he is interested.

"12. The Commissioners reserve the right to waive any informality *in the proposals received*, to disregard the proposal of any failing bidder or contractor, and to reject any and all proposals or parts of a proposal, if bids are requested on separate items.

"13. Good and sufficient bonds to the United States in a penal sum equal to the estimated amount of the contract, with sureties to be approved by the Commissioners of the District of Columbia, will be required from all contractors guaranteeing that their contract will be strictly and faithfully performed to the satisfaction of and acceptance by said Commissioners, and that the contractors will keep new pavements or other new works in repair for a term of five years from the date of the completion of their contract, and to cover all claims for damages that may arise on account of any accident to persons, property, or premises after the commencement of the work and prior

to its completion; and ten per centum of the cost of all new works will be retained as an additional security and a guarantee fund to keep the same in repair for said term, and the money so retained will be disposed of pursuant to the provisions of an act of Congress entitled 'An act authorizing the Treasurer of the United States to credit the District of Columbia with certain moneys in lieu of investing the same in bonds,' approved March 3, 1887. It is hereby expressly understood and agreed that the retain fund shall be subject to the control of the Commissioners of the District of Columbia for the purpose of maintaining the work in repair for the period specified, and the Commissioners, at their discretion, may require of the contractor and his sureties that any portion of the said retain fund which may have been expended for the maintenance of the work shall be made good by further deposit.

"14. When required the contractor will give bond to indemnify the District of Columbia against all claims for damages for and on account of infringement of patent rights of any kind or nature whatsoever.

"15. All loss or damage due to negligence or arising out of the nature of the work to be done, or from any unforeseen or unusual obstructions or difficulties which may be encountered in the prosecution of the same, or from the action of the elements will be sustained by the contractors, who will be required, without cost to the District, to remove from the line of the work all surplus material, earth, rubbish, etc., immediately after completion of the work.

"16. Failure to commence the work at the time specified or to prosecute it thereafter in a satisfactory manner and at a rate of progress necessary, in the opinion of the District Commissioners, for its entire completion within the limits of time fixed by the contract, will be authority for the said Commissioners to suspend the contractors from the work and employ other parties to complete it, or to employ additional labor to assist in its completion, or to annul the contract. All money due the contractors at the date of suspension, annulment, or when additional labor is employed will be applied to the conduct and maintenance of the work, and any excess of cost over and above the amount so retained will be charged against the contractor and sureties, who will each and severally be held liable therefor.

"17. Any interference with, or abusive or threatening conduct toward, an inspector or other District employee, on the part of a contractor, will be authority for the said Commissioners to suspend the contractor from the work and employ other parties to complete it, or to annul the contract.

"18. The contractor must be prepared to do any extra work that may be ordered, in writing, by the Engineer Commissioner, arising out of any modification of the specifications that may appear necessary, and for this he will be paid at the contract rates for work of similar character; or, if the extra work should be of a class for which no rate is fixed by the contract, the actual reasonable cost to the contractor, as determined by the Engineer Commissioner, plus 10 per cent of said cost.

"19. Delay on the part of the District to furnish materials is not to give cause for claims for damages; but the time for completing the work shall be extended as the Engineer shall judge necessary. No application for an extension of time on contracts, for any other cause, will be granted, except on the condition that all extra expense to the District for hire of inspectors, etc., shall be borne by the contractor and deducted from any amounts due or to become due him. In addition, the Commissioners shall have the option of deducting from amounts due or to become due him an amount not to exceed ten dollars a day for every day's extension, estimated as liquidated and fixed damages to the District arising from failure to complete the work in the time specified. The time of completion of the contract is an essential element and consideration.

"20. When any work is begun by the contractor it must be carried on to completion without any unnecessary delay. If the work be delayed by reason of insufficient force of workmen, by failure to provide material, or by any other negligence on the part of the contractor, he shall forfeit $4.00 a day for every inspector em-

ployed on the work for each day's delay. The amount of this forfeiture will be fixed by the Engineer Commissioner.

" 21. Inspectors will be appointed whose duty it shall be to point out to the contractors any neglect or disregard of the specifications of contracts; but the right of final acceptance or rejection of the work will not be waived at any time during its progress. Contractors will be held responsible for the faithful execution of their contracts, and upon all technical questions concerning the execution of the work in accordance with the specifications and the measurements thereof the decision of the Engineer Commissioner of the District of Columbia shall be final. Ordinarily, one inspector will be employed by the District for each section of work under contract; but if, on account of any apparent disregard of the specifications on the part of the contractor, additional inspectors should be required, they will be employed by the District at the rate of $4.00 per diem, in such numbers as, in the opinion of the Engineer Commissioner, may be necessary, and the cost of the same will be charged to the contractor. Any employee of the contractor who shall refuse to obey the order or orders of the inspector of the District of Columbia, or who shall use profane or abusive language to the inspector, or otherwise impede or embarrass the inspector in the performance of his duty, shall be immediately discharged by the contractor and not again employed without the consent of the Commissioners of the District of Columbia.

" 22. Any person who may be engaged by the contractor on this work, and who, in the opinion of the Engineer in charge, obstructs its progress, or disobeys or evades the orders or instructions concerning it, given by the Engineer in charge or his agents, shall be instantly discharged, and such discharge is not to be made the basis of claim for compensation or damages against the District of Columbia or any of its officers or agents.

" 23. The contractor shall promptly discharge, and shall not again employ under this contract, any employee who shall be objected to by the Engineer Commissioner as careless or incompetent, as having interfered with or impeded an inspector in the performance of his duty, or as having been connected with any imperfect or unsatisfactory work done under contract with the United States or the District of Columbia.

" 24. No contract or any interest therein shall be transferred by the parties to whom the award is made. It is a condition of all contracts that such transfers will be null and void, and will cause the contract to be annulled and the work to be given to other parties under the conditions mentioned in these Stipulations.

" 25. Contractors will punctually pay the workmen who shall be employed by them upon the work under their contract in cash current, and not in what is denominated store pay or orders, and will from time to time, and as often as may be required by the Commissioners of the District of Columbia, furnish to said Commissioners satisfactory evidence that all persons who have done work or furnished materials have been paid as herein required. If such evidence is not furnished, such sum or sums as may be necessary for such payment may, in the discretion of the said Commissioners, be retained until such claims shall be fully satisfied.

" 26. Payments will be made monthly, *provided the progress of the work is satisfactory*, upon estimates approved by the Engineer Commissioner, less ten per cent of each estimate to be withheld until the final payment, which will only be made upon the certificate of the said Commissioner that the work has been completed and properly executed to the satisfaction of a majority of the Board of Commissioners, but ten per centum of the cost of all new work will be retained and invested as hereinbefore provided.

" 27. Any doubt as to the meaning of these specifications, instructions, and stipulations, and any obscurity in the wording of them, will be explained by the Engineer, who shall have the right to correct any errors or omissions in them when such correction is necessary for the proper fulfillment of their intention.

" 28. Whenever the word 'Commissioners' is used in these specifications, instructions, and stipulations it is understood to designate the Commissioners of the District of Columbia.

"29. Whenever the word 'Engineer' is used in these specifications, instructions, and stipulations it is understood to designate the Engineer Commissioner of the District of Columbia, or, in his absence, his duly appointed assistants, assistant engineers, and inspectors representing him, limited by the special duties entrusted to them.

"30. These specifications, instructions, and stipulations are hereby acknowledged, accepted, and made part of this contract."

MATERIAL—INSTRUCTIONS AND STIPULATIONS.

The first twelve paragraphs are identical with those for "Labor."

"13. Good and sufficient bonds to the United States in a penal sum equal to the estimated amount of the contract, with sureties to be approved by the Commissioners of the District of Columbia, will be required from all contractors guaranteeing that their contract will be strictly and faithfully performed to the satisfaction of and acceptance by said Commissioners."

"14. [Same as par. 14, 'Labor.']

"15. Delivery will commence on or before

and be completed on or before

Should the contractor fail to commence or complete the deliveries at the time mentioned above (which must be named in the proposal), and in event the contract shall not have been annulled or cancelled, as mentioned in paragraph 16 of these Stipulations, he will be charged with the pay of all inspectors whom it may be necessary to employ because of such failure, which cost will be deducted from any money due or which may become due the contractor, and, in addition, if the Commissioners so elect, with a sum not to exceed ten dollars ($10) per diem for the same period, estimated as liquidated and fixed damages to the District arising from failure to commence or complete the work at the time specified—time of beginning and completion being an essential element and consideration.

"16. Failure to commence the delivery of the material at the time specified or to prosecute it thereafter in a satisfactory manner and at a rate of progress as specified herein will be authority for the Commissioners to suspend the contractors and employ other parties to complete it, to wholly annul said contract, or to purchase the material in such quantities as may be necessary in open market, charging any increased price to the failing contractor. All money due the contractor at the date of suspension, annulment, or when it is decided to purchase in open market, will be retained until the delivery is completed, and be applied to the payment of any increased cost thereof, and any excess of cost over and above the amount so retained will be charged against the contractor and sureties, who will each and severally be held liable therefor.

"17. Inspectors will be appointed whose duty it shall be to point out to the contractors any neglect or disregard of the specifications of the contract; but the right of final acceptance or rejection of the material will not be waived at any time. Upon all technical questions and measurements the decision of the Engineer Commissioner of the District shall be final. Ordinarily, one inspector will be employed by the District for each consignment; but if, on account of any apparent disregard of the specifications on the part of the contractor, additional inspectors should be required, they will be employed by the District at the rate of $4.00 per diem, in such numbers as, in the opinion of the Engineer Commissioner, may be necessary, and the cost of the same will be charged to the contractor. Any employee of the contractor who shall refuse to obey the orders of the inspector or who shall use profane or abusive language to the inspector or otherwise impede or embarrass the inspector in the discharge of his duty shall be immediately discharged by the contractor and not again employed without the consent of the Engineer Commissioner."

"18. [Same as par. 24, 'Labor.']

"19. [Same as par. 25, 'Labor.']

"20. Payments will be made monthly, provided the progress of the deliveries is satisfactory."

Paragraphs 21, 22, 23, and 24 same as paragraphs 27, 28, 29, and 30, 'Labor.'

Payments.—When payments are due, certificates or vouchers

showing indebtedness for work done, services rendered, or materials delivered are made out by the officer supervising the work and approved by at least two Commissioners. The Auditor of the District makes payments on these certificates, by checks on the Treasurer of the United States, signed by the Auditor and by the President of the Board of Commissioners.

Legal Holidays.—In addition to the laws fixing the legal holidays, previously given, it is prescribed that in the District of Columbia, when a legally appointed holiday falls on Sunday, the next succeeding day shall be a holiday within the District, and for all matters of presentation for payment and acceptance, maturity of notes, etc., it shall be considered as is Sunday. (Act Dec. 20, 1881.)

The Act of February 18, 1893, prescribes that every Saturday which under existing laws shall not become a legal holiday in its entirety, in the District of Columbia, shall therein be a legal holiday, from twelve o'clock at noon, for all purposes respecting the presentation for payment or acceptance or the protesting or giving notice of the dishonor of bills of exchange, bank checks, drafts, promissory notes, and all commercial paper whatever, whether made in or beyond said District, and all such paper which otherwise would be due and payable in such District on such half-holiday Saturday, shall therein be due, etc., on the secular or business day next succeeding: provided, however, that any acceptance or payment thereof with interest thereon to said date when the same bears interest made on such half-holiday Saturday, before twelve o'clock noon, shall be lawful. And all such paper whatsoever, which, but for existing law, would be due and payable or presentable for acceptance or payment in said District on any day which is a full legal holiday, or on Sunday, shall, therein, be payable or presentable for acceptance or payment on the secular or business day next succeeding.

Suits against District.—In suits commenced against the District of Columbia, process may be served on any one of the Commissioners.

Interest when authorized by law, in judgments against the District, is at the rate of not exceeding four per centum per annum.

MUNICIPAL WORKS, DISTRICT OF COLUMBIA.

The public works carried on under the Commissioners may be classified as follows:

1. Purchase of ground for and erection of public buildings, such as schoolhouses, police-station houses, etc.
2. Purchase of ground for and repair of streets and roads.
3. Construction and repair of sewers.
4. Construction and repair of water-works and their accessories.
5. Construction and repair of telegraph and telephone lines required for District work, such as fire-signal, police-patrol system, etc.
6. Purchase and erection of lamp-posts and other accessories for street-lighting.
7. Purchase of fire-engines and apparatus for the fire-department.
8. Construction and repair of the bridges under the control of the District.
9. Purchase of the general supplies for all departments of the District Government.
10. Cleaning of streets and alleys.
11. Collection and removal of garbage.
12. Lighting streets and alleys.

Street Pavements.—The street pavements of Washington are of such a high grade of their several classes that the following details from the specifications of 1894, for their construction, are given:

Sheet Asphalt on a Concrete Base.—The space over which the pavement is to be laid is excavated, cleared, trimmed so as to have its top surface parallel to the surface of the proposed pavement, and thoroughly rolled. On this is laid a hydraulic cement-concrete base, 4″ to 6″ thick. The cement used is a high-class natural hydraulic cement. The sand is clean, coarse, sharp river-sand, not containing more than five per cent of loam. The stone is equal in quality to the best Potomac granite, and broken so that 85 per cent shall pass by its largest dimension through a 2″ ring and the remainder shall have no dimension greater than $3\frac{1}{2}$″.

The concrete contains 300 pounds of cement to 2 barrels of sand, and enough broken stone (or half broken stone and half clean washed gravel) to yield a slight excess of mortar when rammed. This is allowed to set, and then the binding-course is placed on.

The binding-course is of clean broken stone coated with asphalt cement. The stone is broken fine enough to pass 85 per cent through a $1\frac{1}{4}''$ screen, with no dimension of the remainder greater than $2''$. After being heated, not less than 5 nor more than 15 per cent shall pass through a No. 10 screen. The stone is heated to 300 degrees F., and then thoroughly mixed by machinery with asphalt cement, in the proportion of 6 to 7 pints of cement to one cubic foot of stone. The cement is made with petroleum residuum, such as is acceptable for surface cements, at 300 to 325 degrees F., and should show a penetration of 100 to 200 degrees F. The proportions and treatment of the binding-course is such that the binder has life and gloss without an excess of cement. While hot it is hauled to the site, spread upon the base in a layer (about $2''$ thick) which when compressed will be $1\frac{1}{2}''$ thick, and rammed and rolled until it is cold.

The wearing-surface is at least $1\frac{1}{2}''$ thick. The materials of which it is made are: 1, asphaltum; 2, heavy petroleum; 3, sharp, clean, river sand; and, 4, fine powder of limestone.

The asphaltum is Trinidad Lake pitch or an equally good one. When Trinidad Lake asphalt is used the crude pitch must be bright, live, and porous, corresponding in chemical composition and physical properties with the best Trinidad pitch. The crude pitch is refined so that the resulting product is smooth and free from lumps of unmelted pitch or organic matter not bituminous, and must not be heated at any time to a temperature of over 375 degrees F.

The heavy petroleum as prepared must have the following characteristics: Specific gravity, Beaumé, 15 to 25 degrees; flash-point, not less than 300 degrees F., taken in a New York State closed oil-tester; distillate at 100 degrees for 30 hours less than 15 per cent.

The melted asphalt is to be brought to a temperature of from 200 to 350 degrees F., and to this is to be added the oil, at a temperature of 150 degrees, in proportions such as to produce an asphalt cement penetrating from 60 to 130 degrees, as may be directed, on the machine in the office of the Inspector of Asphalts and Cements. This requires from 15 to 21 pounds of oil per 100 of refined asphalt. While mixing the oil with the asphalt the mixture must be kept agitated until a homogeneous cement is produced. The appliances for agitation shall be such that this shall be accomplished in at least 10 hours, during which time the temperature must be between 200 and 350 degrees F.

The sand used is the best sharp, clean river-sand. The limestone dust must be in an impalpable powder, all of which can pass through a 30-mesh screen and 75 per cent through a 100-mesh screen.

The surface is made from a mixture of 9 to 16 parts of asphalt cement, 79 to 84 parts of sand, and 3 to 5 parts of limestone dust. The exact proportions of the materials depend on their character and the traffic on the street, but the percentage of bitumen in any mixture, soluble in carbon bisulphide, must not exceed 9 to 13 per cent. The sand at a temperature of 300 degrees has the stone-dust, cold, added to it, and these are then mixed with the asphalt cement, which has been brought to a temperature of 300 degrees, in an apparatus fitted to insure a thorough and homogeneous mixture. This mixture must arrive on the site of the work at a temperature of not less than 250 degrees F. It is then spread with hot iron rakes in a uniform layer thick enough ($2\frac{1}{2}''$) to have when thoroughly compressed a depth of $1\frac{1}{2}''$. It is compressed first with hand-rollers, then a small amount of hydraulic cement is swept over it. The ultimate compression is given with a steam-roller which weighs not less than 250 lbs. to the running inch. The rolling must be continued for at least five hours for every 1000 sq. yds. of pavement.

In many cases the gutters of asphalt roadways are paved for an average width of $2'$ with vitrified brick bedded in the concrete base in a dry mixture of 2 parts sand and 1 part cement, set at right

angles to the curb, toothed into the asphalt surface, and grouted with hydraulic cement.

Sheet Asphalt on old Cobble or Rubble Stone Pavement.—The old pavement is thoroughly cleaned and brought to an approximately even surface. The binder coat is then placed on in such thickness that there shall be at least ½″ of binder above the tops of the highest stones. The wearing-surface is then placed.

The following special instructions for bidders were attached to the specifications for asphalt street work, viz.:

SPECIAL INSTRUCTIONS TO BIDDERS.

"1. The attention of bidders is invited to the clause of the appropriation bill, which says:

"'That under appropriations contained in this act no contract shall be made for making or repairing concrete or asphalt pavement at a higher price than two dollars per square yard for a quality equal to the best laid in the District of Columbia prior to July first, eighteen hundred and eighty-six, and with same depth of base: *Provided*, That these conditions as to price and depth of base shall not apply to those streets on which, in the judgment of the Commissioners, by reason of heavy traffic, poor foundation, or other causes, a pavement of more than ordinary strength is required, in which case the limit of price may be increased to two dollars and twenty-five cents per square yard.'

"2. Bidders must present satisfactory evidence that they have been regularly engaged in the business of laying asphalt pavements which they propose to put down or are reasonably familiar therewith, and that they are fully prepared with the necessary capital, materials, and machinery to conduct the work to be contracted for to the satisfaction of the Commissioners and to begin upon July 1, 1893.

"3. None but the best material of the several descriptions shall be used, and skilled laborers and mechanics shall be employed.

"4. The contractor shall suspend all work under this contract when notified by the Engineer Commissioner that the weather is unsuitable for carrying it on. If work is allowed during cold or freezing weather the contractor shall take such additional precautions as the Engineer Commissioner shall require without additional expense, and under no circumstance shall materials which have been affected by the weather be used.

"5. All materials furnished and work done, not in accordance with these specifications, shall be removed within twenty-four (24) hours after written notice from the Engineer Commissioner, by and at the expense of the contractor, or, in case of failure to do so, it shall be removed and the cost charged to the contractor and deducted from the amount due or which may become due him.

"6. The bidder is expected to examine the site before bidding, as no allowance will be made for any unusual difficulties which may arise, either affecting the original construction or maintenance of the finished work.

"7. No work shall be done between December 15th and March 15th without special permission of the Commissioners.

"8. Contractors shall be responsible for any work done upon any street over plumbers' cuts or other work done by the permission of the Commissioners before the concrete or gravel base is laid.

"9. No materials furnished by the District shall be applied to any other use, public or private, than that for which they are issued to the contractor. The contractor will be held responsible for all materials delivered to him upon requisitions, and shall be charged for all materials delivered upon said requisitions. Should the amount of materials actually delivered exceed the amount used upon the work, the cost to the District of the difference must be made good by the contractor, and will be deducted from any moneys which may be due him.

"10. The Commissioners reserve the right to decide the kind of pavement which will be laid upon each street in the schedule of improvement.

"11. The awards will be made upon each street separately.

"12. If a new asphalt, or one which has not been in use upon streets at least five years, is submitted with bids, the Commissioners reserve the right to limit its use to such extent as they may deem advisable.

"13. Certificates of indebtedness against street railway companies will be given to the contractor for all work done and all materials used within the space which must be paved and kept in repair by said companies in accordance with existing laws.

"GUARANTEE.

"All pavements and other work will be guaranteed and kept in repair by the contractor without cost to the District for a period of five years from date of its acceptance by the Commissioners. The date of acceptance will be the date of the final voucher. Ten per centum of the cost of this work will be retained and disposed of as otherwise provided for herein.

"It is further expressly understood and agreed that if any of the pavements laid should, for any reason whatsoever, within the period of five years prove inferior to the best laid in the District prior to July 1, 1893, then the contractor shall, on demand of the Commissioners, remove such defective pavements and relay them with new material of approved quality and in accordance with these specifications. The Engineer Commissioner shall decide the question of inferiority.

"On expiration of guarantee for maintenance, the work is to be inspected, and all imperfections, depressions, and unevenness of surface, alignment, and level of curbs, sidewalk, etc., on asphalt-block pavements; also cracks, rolls, breaking up of wearing or cushion coat or concrete base, curb alignment and level on asphalt pavement or sidewalk, must be corrected where and to such an extent as the Engineer Commissioner shall direct, upon which the Engineer Commissioner will accept the same in writing, and until such acceptance the guarantee shall be in force."

"*Prices which will be Paid for Additional Work.*

1.	Removing old curb, including haul to property yard.....	$0.06 per lin. ft.
2.	Removing old rubble, cobble, flagging, stone and brick, including haul to property yard	.12 per sq. yd.
3.	Grading and hauling earth, not to exceed 2500 feet.....	.30 per cu. yd.
4.	Grading and hauling macadam, not to exceed 2500 feet..	.50 " " "
5.	Hauling earth and macadam per 500 ft. over first 2500 ft.	.2½
6.	Hauling and setting standard curb.....	.15 per lin. ft.
7.	Resetting curb.....	.08 " " "
8.	Straightening curb.....	.05 " " "
9.	Hauling and setting special granite curb.....	.32 " " "
10.	Laying and relaying brick sidewalks	.25 per sq. yd.
11.	Laying vitrified brick upon 4-inch base	1.00 " " "
12.	Construction granolithic gutter same depth as pavement.	Same price as surface pavement.

"All other extra work will be paid for at cost price plus ten per cent."

Asphalt-block Pavement.—These blocks are 4″ × 5″ × 12″ in size, and are composed of 8 to 12 parts of paving cement and 92 to 88 parts of crushed limestone. The paving cement is similar to that in sheet-asphalt pavements. The bids are required to be accompanied by a specimen block for testing.

The space to be paved is excavated to a depth of 11″, cleared, trimmed to the required surface and crown, and rolled with a five-ton roller. On this is placed a bed of clean gravel, 4″ thick when compressed. None of the gravel is to have a dimension greater than 1½″, and it must not contain more than 6 per cent of clay. This is covered with a 2″ layer of clean sand. On this layer the blocks are laid, in courses with close joints, diagonally to the line of the street, breaking longitudinal joints by a lap of at least 4″. The courses are driven together by a maul, and the blocks of each course are pressed together with a lever. After being placed the blocks are covered immediately with clean, dry sand, and are then rammed, by striking a plank laid over several courses with a heavy rammer.

Asphalt Blocks on Concrete Base.—The site is prepared as before. On this is placed a 4″ or 5″ layer of sand. The asphalt blocks are

placed as before. If the concrete base be 4″ the asphalt blocks are 5″, and the reverse.

Granite Blocks on Concrete.—The site is prepared as before. On this is placed a 4″ or a 6″ layer of concrete laid as for the sheet-asphalt pavement, except that no gravel must be used. On this is placed a 2½″ layer of fine, washed, dry sand. The blocks are laid with close joints, directly upon and imbedded in the sand, in courses, with the longest dimension at right angles to the line of the street. The stones of each course are of uniform width and depth, and are so laid that all longitudinal joints are broken by a lap of at least 2″. The blocks are then covered immediately with clean, fine gravel, hot, which is raked in until all of the joints have been filled. The blocks are then rammed carefully to a firm unyielding bed, with uniform surface and proper grade and crown. Paving cement at a temperature of 300 degrees is then poured into the joints. The cement is to be made by the direct distillation of coal-tar, and in quality to meet the approval of the Engineer Commissioner. This cement is poured in until the sand beneath the blocks and the joints will receive no more, and the joints are filled flush with the upper surface. Not less than 3½ gallons are required for each square yard. Any cement spilled on the surface must be covered with a quantity of fine sand sufficient to absorb it.

The blocks are purchased under a separate contract. They are of syenite or granite, in quality equal to Quincy granite, of uniform fine grain and texture, without lamination or stratification, and free from an excess of mica or feldspar. They are to be not more than 8″ nor less than 6″ long, not more than 4″ nor less than 3″ in width, and not more than 6″ nor less than 5½″ in depth. They must run 42 to the square yard of pavement. They are dressed to present rectangular faces, with straight edges, on top, bottom, and sides. They must not vary more than ½″ from the rectangular shape, nor have any projection greater than ½″.

Granite-block Pavement on Gravel Base.—The base is prepared as for asphalt blocks and the blocks are laid as above. The gravel layer is 4″ thick, and the sand 3″.

Vitrified-brick Pavements.—The 4″ concrete and 2″ sand base are prepared as before. The bricks are placed on edge upon the sand with close joints, and firmly rammed with a double rammer working on an iron plate or on plank. The brick are laid end to end in courses transverse to the line of the street. Longitudinal joints are broken by one half the length of the brick. After placing, the joints are filled with cement as described.

Macadam Roadway.—The road metal is 8″ to 12″ thick after compression, according to the traffic, and is laid in three courses. The site is prepared as usual. On this the lower course of stone is laid to a thickness of 4″ or 6″ after compression, and rolled with a five-ton roller until the stone ceases to sink or creep. The amount of rolling is not less than for ten hours per 1000 sq. yds. of surface. The second course is then spread, wet, and rolled as the first course. The material of the third course is then spread to a thickness which after compression will be ½″. It is wet and rolled like the second course. The stone for the first and second courses is of hard and compact texture and of uniform grain, broken so that the dimensions of each piece lie between 2½″ and 1″. The material for the top course is fine, clean gravel or stone, ⅛″ to ¾″ in the largest dimensions. This course must contain a given proportion of loam or of binding material, if so ordered.

Telford Roadway.—The site is prepared as before for a thickness of metal of 14″. The foundation is made of stones 6″ to 8″ in depth, 3″ to 6″ in width, and from 6″ to 14″ in length, of sufficiently uniform size, laid by hand on their broadest edges, lengthwise across the road, in the form of a close, firm pavement. All projections and irregularities in the upper surface are broken off with a hammer. The spalls and chips, with broken stone or screened gravel, are then spread on the base, in quantity sufficient to fill all irregularities and present an even surface. This base is then thoroughly rolled. The pavement is then completed with a 5″ course of broken stone and a half-inch course of fine material, as prescribed for Macadam pavements.

Granite Curb, 6″ × 20″.—This must be of good texture and color, dressed straight down 12″ on face and 3″ on back, and chiseled 6″ deep on the joint, with no projection beyond the chiseled portion of the joint. The joints must be cut to a true right angle to face and top. The top is bevelled $\frac{1}{4}$″. The face and top are true plane surfaces with the angle between the face and top well defined. The length is from 6′ to 12′ and the depth 20″ to 24″. The bed must not be less than 6″.

To lay this curb, a trench is dug 18″ wide and 24″ deep. A 4″ bed of gravel is laid in the bottom and thoroughly rammed. On this the curb is set to line and grade, with close joints and even and continuous surfaces. The trench is then filled to within 10″ from the top of the curb, with gravel rammed in 3″ to 4″ layers.

Granite Curb, 8″ × 8″.—This is similar to the other, except that the width of bed is not less than 8″, and the bed is rough dressed, to give a good bearing. The depth is from 8″ to 10″.

This curb is laid on a bed of hydraulic cement concrete, 18″ wide, and with base 14″ below the grade of the curb top. The curb is set when the bed is 6″ thick, with the inside face 6″ from the inside face of the base. The concrete is then raised 3″ further on the inside and $1\frac{1}{2}$″ on the outside of the curb. The concrete is similar to that in street-pavement foundations.

The following prices were paid under contracts for material and labor in the fiscal year 1893:

Sheet-asphalt pavement on 6″ concrete base, exclusive of grading, per sq. yd	$2.25
Sheet-asphalt pavement on 4″ concrete base, exclusive of grading, per sq. yd	2.00
Asphalt-block pavement on gravel base, exclusive of grading, per sq. yd	2.00
Granite-block pavement on gravel base, exclusive of grading and cost of blocks, per sq. yd	$0.90 to 0.95
Granite blocks delivered at yards, $48 to $52 per M, per sq. yd.,	2.02 to 2.18
Vitrified-brick paving, including grading and cost of materials, per sq. yd	1.86
Ordinary macadam roadway, 12½″, exclusive of grading, per sq. yd.	1.05
Setting 6″ × 20″ granite curb, exclusive of cost of curb, per lin. ft.	.15 to .30
6″ × 20″ granite curb, delivered at property yard, per lin. ft.	$1.08
Vitrified brick, delivered at property yards, per M	$16.68 to $18.00
Grading earth, per 1000 ft. haul, per cu. yd	.32 to .40
Paving brick, delivered at property yard, per M	$9.00
Sewer " " " " " " "	8.25
Terra-cotta pipe, per lineal foot, 6″, 8 cts.; 8″, 12½ cts.; 10″, 16¼ cts.; 12″, 21¼ cts.; 15″, 31¼ cts.; 18″, 42¼ cts.; 21″, 65 cts.; 24″, 95.	
Vitrified sewer-bricks, per M	$19.00
Cast-iron pipe, delivered on cars, per ton of 2240 lbs., 3″, $28.93; 4″ and 6″,	$26.69

BUILDING FOR LIBRARY OF CONGRESS.

By the Sundry Civil Bill of October 2, 1888, the charge of the construction of the new building for the Library of Congress was entrusted to the Chief of Engineers of the Army, and by the bill of August 5, 1892, this charge was entrusted to the then and present Chief of Engineers, Brigadier-General Thomas L. Casey by name, who is to continue in charge until the completion of the building, whether on the active or retired list of the Army.

The building is located 1000′ eastward of the Capitol. Bernard R. Green is the superintendent and engineer in local charge, assisted by Paul J. Pelz, designer of the architectural features. The reading-room, 100′ in diameter, occupies the rotunda in the centre of the building, from which radiate the book-stacks, each nine tiers high, lighted from four court-yards. The exterior walls are of granite from Concord, N. H., and the court walls of a cream-white enamelled brick, trimmed with Maryland granite. The main stair-hall is white marble, and the rotunda of colored marble. The length of the building is 470′; width, 340′; height to finial of dome lantern, 190′. The construction began in 1889.

The cost of the building is limited, in the Act approved March 2, 1889, to $5,500,000, exclusive of appropriations made prior to that date, of which a balance of $245,567.94 was available Oct. 2, 1888. Appropriations are made in the Sundry Civil Bill annually, and the

money is available until expended. The disbursements are made under the general laws and regulations (see Chap. I). Materials are generally obtained by contract, and the work is done by hired labor. The General Instructions and Conditions of Proposals and Guarantees are given below.

GENERAL INSTRUCTIONS AND CONDITIONS.

1. All bids must be made upon printed forms to be obtained at this office.

2. The guarantee bond attached to each bid must be executed according to form by two responsible sureties, to be certified to as good and sufficient sureties by a United States judge, district attorney, clerk of United States court, collector of customs, or other United States officer.

3. The bond accompanying the contract must be executed and certified in a manner similar to the guarantee bond.

4. Neither firms nor bonded officers of the United States will be accepted as sureties, nor will a partner be accepted as surety for a copartner or for a firm of which he is a member, nor an officer of a corporation as surety for such corporation.

5. All signatures to the guarantee or contractor's bond must have affixed to them seals of wax or wafer.

6. When firms bid, the individual names of the members must be signed in full, giving Christian names; but the signers may, if they choose, describe themselves, in addition, as doing business under a given name and style as a firm.

7. The place of residence of every bidder must be given after his signature, which must be written in full.

8. All prices must be written as well as expressed in figures, and any alterations by erasures or interlineations should be explained or noted in the proposal over the signature of the bidder.

9. All bids must be strictly in accordance and conformity with the specifications, drawings, samples, or models therefor, supplied by this office.

10. The bidder must, if required, satisfy the Chief of Engineers, U. S. Army, of his ability to furnish the materials or perform the work for which he bids, or both.

11. Reasonable grounds for supposing that any bidder is interested in more than one bid for the same item will cause the rejection of all bids in which he is interested.

12. The United States reserves the right to reject any and all bids, and to waive informalities; also, to disregard the bid of any failing bidder or contractor, known as such to this office.

13. The contract and contractor's bond, which the successful bidder and his sureties under the contract shall enter into, will be in the form which can be inspected at this office, and which will be furnished, if desired, to parties proposing to put in bids. Bidders are to be considered as accepting the terms and conditions contained in such form of contract.

14. Transfers of contracts or interests in contracts are prohibited by law.

15. It is unlawful to assist or encourage in any manner whatever the importation or migration of foreign labor into the United States, its Territories, or the District of Columbia, under contract or agreement of any kind previous to such importation or migration. (See Stat. at Large, vol. 23, page 332, and vol. 24, page 414.)

16. In awarding contracts preference will be given to articles of domestic production and manufacture, conditions of quality and price (including in the price of foreign productions or manufactures the duties thereon) being equal, and all labor thereon shall be performed within the jurisdiction of the United States. (See Stat. at Large, vol. 18, part 3, page 455, and R. S., par. 3716.)

17. Any proper information desired by the bidder, and not found in the specifications herewith or in the accompanying schedule, drawings, samples, or models, may be had on application to this office.

18. Each sample submitted with bids must bear the name of the bidder and reference to the bid to which it belongs distinctly and permanently marked upon it. It must be delivered at this office at

the bidder's expense before the hour of opening bids, and will be retained by the Government as long as may be deemed advisable by the Chief of Engineers, U. S. Army.

19. Payments will be made only at such times and in such amounts, during the progress of the contract, as may be deemed advisable by the Chief of Engineers, U. S. Army.

20. Ten per centum will be retained from each payment until the completion of the contract, except where (as in cases in which no payment is to be made until a work is completed) such retentions may, in the opinion of the Chief of Engineers, U. S. Army, properly be dispensed with.

21. Before final payment and settlement, the contractor must, if required, satisfy the Chief of Engineers, U. S. Army, that all wages due by him on account of the contract have been settled.

22. All materials or services furnished must be delivered or performed at such places on the site of the Building for the Library of Congress and in such order and at such times, as may be directed under the terms of the contract.

23. All materials or work performed under the contract shall be entirely to the satisfaction of the Chief of Engineers, U. S. Army, and his decisions upon all questions of quality or quantity arising out of the contract shall be final.

24. All materials delivered or work performed under the contract, that may be rejected, must, upon due notice of such rejection, be removed from the premises of the building, or corrected by the contractor without delay and at his own cost.

25. All drawings referred to in the specifications are permanently on file in this office. Photographic or other copies thereof, only, may be sent out to bidders and supplied for use of contractors, but in general will not be attached to either specifications or contracts.

26. A copy of the advertisement, general instructions and conditions, specifications, and proposals will be attached to the contract, and form a part of it.

27. The premises of the contractor shall at all times during the progress of the work be open to access by the Superintendent and Engineer, or any person authorized by the Chief of Engineers, U. S. Army, for the purpose of inspection of the work under the contract.

28. If the contractor is not present on any part of the work wherever or whenever it may be necessary to give directions to him, orders will be given by the Superintendent and Engineer, the overseer, or inspectors in the employment of the United States, to, and shall be received and obeyed by, the foremen or other employees of the contractor who may have immediate charge of the men employed on the particular work in relation to which the orders may be given.

29. The contractor shall, when required to do so by the Superintendent and Engineer, remove from the work any foreman, workman, or other employee of the contractor, who shall refuse or neglect to obey the directions of the Superintendent and Engineer, the overseer, or inspector in the employment of the United States, or who shall perform his work in a manner contrary to the specifications and directions of the Superintendent and Engineer, or who shall be deemed by him to be incompetent or unfaithful.

30. No work will be considered as accepted which may be defective in its construction, or deficient in any of the requirements of these specifications, in consequence of any failure of any inspector or subordinate agent of the United States to point out said defect or deficiency during construction; and the contractor will be required to correct any imperfect work whenever discovered, before final acceptance of the work.

31. The contractor's employees upon the site of the Building for the Library of Congress shall at all times conform to the police rules and discipline established by the Superintendent and Engineer and enforced by the overseer.

32. The contractor shall protect and indemnify the United States and all persons acting under it for all liability on account of any patent-rights, granted by the United States, which may affect the articles or materials or their application required by the specifications.

33. All additional expense to the United States, by reason of extension of the contract at the request of the contractor, shall be deducted from payments due or to become due to the contractor.

34. Bids will not be received from parties who are not themselves directly and regularly engaged in the manufacture or sale, as the case may be, of the articles, or in the performance of the work for which they bid.

35. Bidders are invited to be present at the opening of the bids.

36. The Superintendent and Engineer will decide when the time fixed upon for the opening has arrived, and no proposal for that opening will thereafter be received as formal.

37. All proposals must be enclosed in suitable envelopes, securely sealed, indorsed as bids, and addressed to the "Superintendent and Engineer, Building for Library of Congress," and be delivered at this office before or at the time appointed for the opening; and no responsibility shall be attached to said office for the premature opening of any proposal not so indorsed as to show that it is a proposal and the particular purpose for which it is made.

38. Act approved August 1, 1892. (See Chap. I, page 1.)

Under date of December 3, 1894, the Engineer in charge reports that the last stone of the superstructure was laid on July 7, 1894. The building was then under roof, all of the windows glazed, and much of the interior work finished. The appearance of the building Nov. 20, 1894, is shown in the frontispiece. Plate XXXVI shows it during construction.

The following table gives the formal contracts which were in force in 1894:

Date.	Name of Contractor.	Subject of Contract.	Price or Amount.	Condition, Dec. 3, 1894.
1889				
July 29	New England Granite Works.	Cut granite for front walls	$1,221,600.72	Completed
1892				
Nov. 30	Tacony Iron and Metal Co.	Iron door and window frames, casings, etc.	54.513.00	"
Dec. 29	Batterson, See & Eisele	Marble-work	279,111.90	"
29	W. H. Evans & Son	" "	325,700.00	In force
29	Vermont Marble Co.	" "	17,828.00	"
29	Chas. E. Hall & Co.	Marble-work	$2,260.00	Completed
29	" " " " "	" "	2,261.00	"
29	" " " " "	" "	6,690.00	"
29	Kenesaw Marble Co.	" "	5,500.00	"
29	W. H. Evans & Son	" "	3,104.00	"
Jan. 27	Tacony Iron & Metal Co.	Ironwork in dome	11,050.00	"
Mar. 20	Pneumatic and Electric Tool Co.	Hire of tools and machinery (approximate)	2,023.00	In force
Apr. 11	Davidson Sons Marble Co.	Marble-work	33,750.00	Completed
June 8	Washington Brick Machine Co.	Bricks, per M.	6.23	In force
24	John B. Lord	Sand, per cubic yard.	1.00	"
Aug. 1	Clark Bros.	Cement { in bbls., per bbl. / in bags, per bag }	1.12 / .88	Completed
18	Brown-Ketcham Iron Works	Iron roofs, etc.	35,276.19	"
18	Empire Fireproofing Co.	Roofing tile, per running foot	.11	"
18	Hallowell Granite Works.	Cut granite for steps, copings, etc.	29,253.40	"
27	Tacony Iron and Metal Co.	Iron door and window frames	8,900.00	"
27	Clarence N. Boyd	Glass	6,573.00	"
27	Jackson & Sharp Co.	Mahogany sash, etc.	8,651.00	"
27	Brown-Ketcham Iron Works.	Traveling scaffolds	2,239.90	"
28	Pickel Marble and Granite Co.	Marble deck flags, etc.	35,890.40	In force
Oct. 3	W. B. Morgan	Pipe covering	5,522.00	Completed
Nov. 9	Chas. Werner	Coal, per ton	4.53	"
14	Yale & Towne Manufacturing Co.	Bronze hardware	2,639.01	"
1894				
Feb. 1	Snead & Co. Iron Works	Book shelves	67,214.00	In force
21	" " " " "	Iron framework and lathing	2,407.00	Completed
21	Francis Miller	Glass	7,720.00	"
21	McDaniel & Harvey Co.	Galvanized sheet iron, etc.	1,370.00	"
21	James Clendenin	Sheet copper	8,437.79	"
27	L. Schreiber & Sons Co.	Iron stairways, etc.	10,527.70	"
Apr. 27	Evans Marble Co.	Marble work	38,965.00	In force
May 12	Phœnix Iron Co.	Iron roofs, skylights, etc.	13,281.88	"
June 19	Church & Stephenson.	Lumber, etc. (estimated).	7,394.50	"
19	Jas. H. McGill	Plaster and hair "	1,873.00	"
July 2	Frank M. Lee	Lime, per barrel	0.48	"
14	Simplex Electrical Co.	Electric wire	3,045.73	"
Aug. 9	Expanded Metal Fireproofing Co.	Iron furring and lathing.	10,100.00	Completed
Sept. 1	Builders' Iron Foundry	Iron and marble stairways	9,000.00	In force
Oct. 1	Norcross Bros.	Cut granite for approaches	47,260.00	"
16	Chas. Werner	Coal (estimated)	3,121.25	"
Nov. 9	Mather Electric Co.	Dynamos	6,400.00	"

BUILDING FOR LIBRARY OF CONGRESS DURING CONSTRUCTION.

"In addition to the contracts above enumerated orders are in force for the architectural figures, alto-relievos, and bronze doors, required for the ornamentation of the building, chiefly in the rotunda and stair hall, amounting to $190,200."

The total amount expended from October 2, 1888, to December 3, 1894, is $4,337,438.44, and at the latter date the outstanding liabilities, including uncompleted contracts, was $566,817.55.

"During the coming year [1895] the marble-work, plastering, stucco-work, woodwork, flooring, electric installation, corner-tower stairs, shelving for the reading-room alcoves, elevators, machinery for transmission, plumbing, painting, approaches to the west front, and work on the grading and arrangement of the grounds will be carried on and many of these pieces of work finished."

A tunnel will also be constructed between the Library building and the Capitol, with suitable apparatus for the rapid transmission of books, papers, and messages. It is expected that the building will be finished in 1897, within the limit of cost.

PUBLIC BUILDINGS AND GROUNDS IN WASHINGTON, D. C. WASHINGTON AQUEDUCT.

"The Chief of Engineers shall have charge of the public buildings and grounds in the District of Columbia, under such regulations as shall be prescribed by the President through the War Department, except those buildings and grounds which are otherwise provided for by law." (Sec. 1797, R. S.)

"All estimates for public buildings and grounds in charge of the Chief of Engineers shall be approved and submitted by the Secretary of War, through the Treasury Department, as other estimates, to the two Houses of Congress; and all appropriations which have been or may be hereafter made for repairs or improvements of the public buildings and grounds in the District of Columbia, and now in charge of the Chief of Engineers, shall be expended under the direction of the Secretary of War." (Sec. 1798, R. S.)

"The Chief of Engineers shall have the immediate superintendence of the Washington Aqueduct, together with all rights, appurtenances, and fixtures connected with the same, and belonging to the United States, and of all other public works and improvements in the District of Columbia in which the Government has an interest, and which are not otherwise specially provided for by law." (Sec. 1800, R. S.)

"He shall obey, in the discharge of the duties mentioned in the preceding section, such regulations, pursuant to law, as may be prescribed by the President, through the Department of War." (Sec. 1801, R. S.)

"All moneys appropriated or hereafter appropriated for the Washington Aqueduct, and for other public works in the District of Columbia, not otherwise expressly provided for by law, shall be expended under the direction of the Secretary of War." (Sec. 1802, R. S.)

"*Be it enacted, etc.*, That the lines of telegraph, connecting the Capitol with the various Departments in Washington, constructed under and by virtue of the act of Congress approved March third, eighteen hundred and seventy-three, entitled 'An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June thirtieth, eighteen hundred and seventy-four, and for other purposes,' be, and the same are hereby, placed under the supervision of the officer in charge of the public buildings and grounds; and that the said officer be authorized and empowered to make rules and regulations for the working of said lines." (Act appd. Feb. 4, 1874.)

Two officers with offices in Washington are detailed for duty under the Chief of Engineers in charge of the works enumerated in the foregoing paragraphs, one with the rank of Colonel (Act of March 3, 1873), in charge of public buildings and grounds, and the telegraph lines, and one in charge of the Washington Aqueduct.

The duties of the former officer include the charge of the Executive Mansion and grounds; the charge of all public buildings, rented

or otherwise, occupied by the War Department, or any of its bureaus or offices in the District of Columbia, so far as their preservation, care, and safety are concerned; the care of the various reservations, squares, and circles in the District, including the construction and repair of the various roads, pavements and walks, fences, seats, fountains, water-pipes and fire-plugs, lamps, etc., therein; and the care of the telegraph lines connecting the Capitol with the Departments and the Government Printing Office.

The repair of the Government Printing Office and the construction of a fire-proof building upon the lot now occupied by the stables of the Government Printing Office were provided for and placed in the charge of the Chief of Engineers, in the Sundry Civil Acts of August 18, 1894, and March 2, 1895, respectively. The work is to be carried on by the Officer in Charge of Public Buildings and Grounds. The amount appropriated for the new building is $121,121.90.

The duties of the second officer include the charge of the Washington Aqueduct, of the project for increasing the water-supply of Washington, and the erection of fishways at Great Falls.

CHAPTER VIII.

FORMS.

ENGINEER DEPARTMENT FORMS.*

Form of Proposals, with Guarantee, Justification of the Guarantors, and Certificate.

[FORM 18.]

PROPOSAL FOR.....

To , 189

SIR: In accordance with your advertisement of , 189 inviting Proposals for and subject to all the conditions and requirements thereof, and of your dated , 189 , copies of both of which are hereto attached, and, so far as they relate to this proposal, are made a part of it, we (or) I propose to furnish

We (or) I make this proposal with a full knowledge of the kind, quantity, and quality of the articles required, and, if it is accepted, will, after receiving written notice of such acceptance, enter into contract within the time designated in the advertisement, with good and sufficient sureties for the faithful performance thereof.

[Signature].....
[Address].....
[Signature].....
[Address]..... .....

[Signed in duplicate or in triplicate, as the case may require.]

GUARANTEE.

We, , of , in the State of , and of , in the State of , hereby guarantee and bind ourselves and each of us, our and each of our heirs, executors, and administrators, to the effect that if the bid of , herewith accompanying, dated , 189 , for furnishing shall be accepted in whole or in part within sixty (60) days from the date of the opening of proposals, the said bidder, , will, within days after being notified of such acceptance, enter into a contract with the United States in accordance with the terms and conditions of the advertisement, and will give bond with good and sufficient sureties for the faithful and proper fulfillment of the same. And in case the said bidder shall fail to enter into contract within the said days with the proper officer of the United States, and furnish good and sufficient bond for the faithful performance of the same according to the terms of said bid and advertisement, we and each of us hereby stipulate and guarantee, and bind ourselves and each of us, our and each of our heirs, executors, and administrators, to pay unto the United States the difference in money between the amount of the bid of the said bidder and the amount for which the proper officer of the United States may contract with another party to furnish said if the latter amount be in excess of the former, for the whole period covered by the proposal.

WITNESSES:

....[SEAL.]
....[SEAL.]

Dated , 189 .

[Executed in duplicate.]

JUSTIFICATION OF THE GUARANTORS.

STATE OF }
County of } *ss:*

I, one of the guarantors named in the within guarantee, do swear that I am pecuniarily worth the sum of dollars, over and above all my debts and liabilities.

[Signature of guarantor] .....

Before me

Signature of officer administering oath, with seal, if any. .....

* For regulations and instructions relating to these forms see Chapter II.

STATE OF } ss:
County of }

I, one of the guarantors named in the within guarantee, do swear that I am pecuniarily worth the sum of dollars, over and above all my debts and liabilities.

[Signature of guarantor].....

Before me

Signature of officer administering oath, with seal, if any, }.....

CERTIFICATE

I, , do hereby certify that and the guarantors above named, are personally known to me, and that, to the best of my knowledge and belief, each is pecuniarily worth, over and above all his debts and liabilities, the sum stated in the accompanying affidavit subscribed by him.

[Signature of certifying official].....

NOTE.—The certificate may be given separately as to each guarantor, and modified accordingly.

Form for Contracts.

[FORM 19.]

Articles of Agreement entered into this day of eighteen hundred and ninety- , (189 ,) between , Corps of Engineers, U. S. Army, of the first part, and and partners, doing business under the firm-name of of of the county of , State of of the second part :

This agreement witnesseth that, in conformity with the advertisement and specifications hereunto attached, and which form a part of this contract, the said for and in behalf of the United States of America, and the said for , heirs, executors, and administrators, have mutually agreed, and by these presents do mutually covenant and agree, to and with each other, as follows :

All materials furnished and work done under this contract shall, before being accepted, be subject to a rigid inspection by an inspector appointed on the part of the Government, and such as not conform to the specifications set forth in this contract shall be rejected. The decision of the engineer officer in charge as to quality and quantity shall be final.

The said shall commence on or before the day of , eighteen hundred and ninety- , (189 ,) and shall complete the on or before the day of eighteen hundred and ninety , (189 .)

If, in any event, the party of the second part shall delay or fail to commence with the delivery of the material or the performance of the work on the day specified herein, or shall, in the judgment of the engineer in charge, fail to prosecute faithfully and diligently the work in accordance with the specifications and requirements of this contract, then, in either case, the party of the first part, or his successor legally appointed, shall have power, with the sanction of the Chief of Engineers, to annul this contract by giving notice in writing to that effect to the party (or parties, or either of them) of the second part ; and, upon the giving of such notice, all money or reserved percentage due or to become due to the party or parties of the second part by reason of this contract shall be and become forfeited to the United States ; and the party of the first part shall be thereupon authorized, if an immediate performance of the work or delivery of the materials be in his opinion required by the public exigency, to proceed to provide for the same by open purchase or contract, as prescribed in Section 3709 of the Revised Statutes of the United States : *Provided, however*, that if the party (or parties) of the second part shall by freshets, ice, or other force or violence of the elements, and by no fault of his or their own, be prevented either from commencing or completing the work, or delivering the materials at the time agreed upon in this contract, such additional time may, in writing, be allowed him or them for such commencement or completion as, in the judgment of the party of the first part, or his successor, shall be just and reasonable ; but such allowance and extension shall in no manner affect the rights or obligations of the parties under this contract, but the same shall subsist, take effect, and be enforceable precisely as if the new date for such commencement or completion had been the date originally herein agreed upon.

If, at any time during the prosecution of the work, it be found advantageous or necessary to make any change or modification in the project, and this change or modification should involve such change in the specications as to character and quantity, whether of labor or material, as would either increase or diminish the cost of the work, then such change

or modification must be agreed upon in writing by the contracting parties, the agreement setting forth fully the reasons for such change, and giving clearly the quantities and prices of both material and labor thus substituted for those named in the original contract, and before taking effect must be approved by the Secretary of War: *Provided*, that no payments shall be made unless such supplemental or modified agreement was signed and approved before the obligation arising from such modification was incurred.

No claim whatever shall at any time be made upon the United States by the party or parties of the second part for or on account of any extra work or material performed or furnished, or alleged to have been performed or furnished under or by virtue of this contract, and not expressly bargained for and specifically included therein, unless such extra work or materials shall have been expressly required in writing by the party of the first part or his successor, the prices and quantities thereof having been first agreed upon by the contracting parties and approved by the Chief of Engineers.

The party of the second part shall be responsible for and pay all liabilities incurred in the prosecution of the work for labor and material.

It is further understood and agreed that in case of failure on the part of the party of the second part to complete this contract as specified and agreed upon, that all sums due and percentage retained, shall thereby be forfeited to the United States, and that the said United States shall also have the right to recover any or all damages due to such failure in excess of the sums so forfeited, and also to recover from the party of the second part, as part of said damages, whatever sums may be expended by the party of the first part in completing the said contract, in excess of the price herein stipulated to be paid to the party of the second part for completing the same.

Payments shall be made to the said when the contracted for shall have been delivered and accepted, reserving per cent from each payment until the whole shall have been so delivered and accepted.

Neither this contract nor any interest therein shall be transferred by the said to any other party; and any such transfer shall cause the annulment of the contract so far as the United States are concerned. All rights of action, however, to recover for any breach of this contract by the said are reserved to the United States.

No member of or delegate to Congress, nor any person belonging to, or employed in, the military service of the United States, is or shall be admitted to any share or part of this contract, or to any benefit which may arise herefrom.*

This contract shall be subject to approval of the Chief of Engineers, U. S. A.

In witness whereof the undersigned have hereunto placed their hands and seals the date first hereinbefore written.

WITNESSES:

.... { ..... [SEAL.]
..... { ..... [SEAL.]
..... { ..... [SEAL.]
..... { ..... [SEAL.]

(Executed in quintuplicate.)

Approved: , 189 .

....., *Brig.-Gen., Chief of Engineers.*

† I do solemnly swear that the foregoing is an exact copy of a contract made by me personally with ; that I made the same fairly, without any benefit or advantage to myself, or allowing any such benefit or advantage corruptly to the said or any other person; and that the papers accompanying include all those relating to the said contract as required by the statute in such case made and provided.

....., *Corps of Engineers.*

Subscribed and sworn to before me this day of

.....

[FORM 20.]

CONTRACTOR'S BOND.

Know all men by these presents, That we, , of , as principal, and , of , and , of , as sureties, are

---

*NOTE.—Here add to any contract made with an incorporated company for its general benefit the following words, viz.: "But this stipulation, so far as it relates to members of or delegates to Congress, is not to be construed to extend to this contract."—*See* Sec. 3740, Revised Statutes.

† NOTE.—This affidavit is required only on the quintuplicate copy of contract intended for the Returns Office, Department of the Interior.—A. R. 669.

NOTE.—The copy of contract for the Bureau must be accompanied with an abstract of the bids, and copy of each bid and advertisement, unless previously furnished.—*See* also A. R. 655.

NOTE.—See Circular No. 18, O. C. of E., Oct. 18, 1887. *See* also Circular No. 10, O. C. of E., Aug. 3, 1889.

held and bound unto the UNITED STATES OF AMERICA in the penal sum of dollars, to the payment of which sum, well and truly to be made, we do bind ourselves, our heirs, executors, and administrators, jointly and severally, firmly by these presents.

Given under our hands and seals this day of , 189 .

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the above-bounden ha , on the day of , 189 , entered into a contract with , Corps of Engineers, U. S. Army, for .

Now, therefore, if the above-bounden , heirs, executors, and administrators, shall and will, in all respects, duly and fully observe and perform all and singular the covenants, conditions, and agreements, in and by the said contract agreed and covenanted by to be observed and performed, and according to the true intent and meaning of the said contract, and as well during any period of extension of said contract that may be granted on the part of the United States as during the original term of the same, including the covenant that the said shall be responsible for all liabilities incurred in the prosecution of the work for labor and materials, and shall promptly make payment to all persons supplying * labor and materials in the prosecution of the work provided for in the said contract, then the above obligation shall be void and of no effect; otherwise to remain in full force and virtue.

WITNESSES:

.... [L. S.]†
.... [L. S.]†
.... [L. S.]†

(Executed in duplicate.)

STATE OF } ss:
County of }

I, , one of the sureties named in the within bond, do swear that I am pecuniarily worth the sum of dollars, over and above all my debts and liabilities.

[Signature of surety.] .....

Before me,

Signature of officer administering oath, with seal, if any. } .....

---

* Insert—him or them.

† Must be sealed with wax or other adhesive substance.

STATE OF } ss:
County of }

I, , one of the sureties named in the within bond, do swear that I am pecuniarily worth the sum of dollars, over and above all my debts and liabilities.

[Signature of surety.] .....

Before me,

Signature of officer administering oath, with seal, if any. } .....

I, , do hereby certify that and , the sureties above named, are personally known to me, and that, to the best of my knowledge and belief, each is pecuniarily worth, over and above all his debts and liabilities, the sum stated in the accompanying affidavit subscribed by him.

[Signature of certifying official.] ....

NOTE.—The certificate may be given separately as to each surety, and modified accordingly.

[FORM 20 *b*.]

CONTRACTOR'S BOND.

FORM WHERE PRINCIPAL IS A CORPORATION AND THE SURETY IS A SURETY COMPANY.

Know all men by these presents, that we, , a corporation created under the laws of the State of , and doing business at , in the county of , in said State, as principal, and , a corporation created under the laws of the State of , and doing business at in the county of and State of , as surety, are held and firmly bound unto the United States of America in the just and full sum of dollars, lawful money of the United States, to be paid to the United States; for which payment, well and truly to be made, we bind ourselves, our and each of our successors and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, That whereas the above-bounden ha , on the day of , 189 , entered into a contract with the United States represented by for

Now therefore, If the above-bounden shall and will, in all respects, duly and fully observe and perform all and singular the

covenants, conditions, and agreements in and by the said contract agreed and covenanted by said , to be observed and performed, and according to the true intent and meaning of the said contract, and as well during any period of extension of said contract that may be granted on the part of the United States as during the original term of the same, including the covenant that the said shall be responsible for all liabilities incurred in the prosecution of the work for labor and materials and shall promptly make payment to all persons supplying[1] labor and materials in the prosecution of the work provided for in the said contract, then the obligation shall be void and of no effect; otherwise to remain in full force and virtue.

IN WITNESS WHEREOF, The parties hereto have executed this instrument this day of , 189 ; the name and corporate seal of said principal being hereto affixed and these presents duly signed by its[2] , pursuant to a resolution of its[3] passed on the day of , A. D. 189 , a copy of the record of which is hereto attached; and the name and corporate seal of said surety being hereto affixed and these presents duly signed by its[2] , pursuant to resolution of its[3] passed on the day of , A. D. 189 , a copy of the record of which is hereto attached.

In presence of

.....

....[4]

by.....

In presence of

....

....[4]

by.....

I, , hereby certify that the above-named[5] is a corporation doing business in , and in my opinion is a good and sufficient surety for the purposes of this bond.

....

U. S.....

(Date).....

(Executed in duplicate.)

[1] Insert—him or them.
[2] The president or officer authorized to sign for the corporation.
[3] The board of directors or other governing body of the corporation.
[4] Here affix the corporate seal.
[5] Name of surety.

(FORM 20 *c*.)

CONTRACTOR'S BOND.

FORM WHERE PRINCIPAL IS AN INDIVIDUAL (OR INDIVIDUALS) OR A PARTNERSHIP FIRM, AND THE SURETY IS A SURETY COMPANY.

Know all men by these presents, That we, , as principal , and a corporation created under the laws of the State of and doing business at , in the county of , and State of , as surety, are held and firmly bound unto the UNITED STATES OF AMERICA in the just and full sum of dollars, lawful money of the United States, to be paid to the United States; for which payment, well and truly to be made, we bind ourselves, our and each of our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

The condition of this obligation is such, That whereas the above-bounden ha , on the day of , 189 , entered into a contract with the United States, represented by , for

NOW, THEREFORE, if the above-bounden shall and will, in all respects, duly and fully observe and perform all and singular the covenants, conditions, and agreements in and by the said contract agreed and covenanted by said to be observed and performed, and according to the true intent and meaning of the said contract, and as well during any period of extension of said contract that may be granted on the part of the United States as during the original term of the same, including the covenant that the said shall be responsible for all liabilities incurred in the prosecution of the work for labor and materials and shall promptly make payment to all persons supplying* labor and materials in the prosecution of the work provided for in the said contract, then the above obligation shall be void and of no effect; otherwise to remain in full force and virtue.

IN WITNESS WHEREOF, the parties hereto have executed this instrument this day of 189 ; the name and corporate seal of said surety being hereto affixed and these presents duly signed by its[1] pursuant to resolution of its[2] passed

*Insert—him or them.
[1] The president or officer authorized to sign for the corporation.
[2] The board of directors or other governing body of the corporation.

on the day of , A. D. 189 , a copy of the record of which is hereto attached.

In presence of

.... [L.S.]*

.... [L.S.]*

In presence of

.....

.....

.....[1]

by .....

I, , hereby certify that the above-named is a corporation doing business in and in my opinion is a good and sufficient surety for the purposes of this bond.

....

(Date) U. S.....

(Executed in duplicate.)

[1] Here affix the corporate seal.

[2] Name of surety.

* Must be sealed with wax or other adhesive substance.

Ordinary Voucher.

[FORM 8.]

Appropriation for.....

The United States, (For.....)

To....., Dr.

Location : .....

DATE. 189 .	DESIGNATION.	APPLICATION.	COST. Dollars.	COST. Cts.

I certify that the above account is correct and just; the articles have been expended and applied to the purpose for which purchased, except those marked , which will be (or have been) accounted for in my return for the quarter of fiscal year 189 .

.....

....., *Corps of Engineers.*

Received at , this day of , 189 , from Corps of Engineers, the sum of dollars and cents, in full payment of the above account.

.....

[Signed in Duplicate.]

Special Voucher.

[FORM NO. 8*a*.]

FOR EMERGENCY PURCHASES OF SMALL AMOUNT.*

APPROPRIATION FOR.....

We, the subscribers, hereby acknowledge to have received of , Corps of Engineers, the sums herein specified opposite our respective names, being in full for supplies for party on , during the month of , 18 , having signed duplicate receipts.

Number.	Date of Purchase, 18 .	From Whom Purchased.	Quantity.	Articles.	Rate.	Am't Paid. Dolls.	Am't Paid. Cts.	Application.	Number.	Signatures.	Witnesses.
1	....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....
2	....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....
3	....	.....	.....	.....	.....	.....	.....	.....	3	.....	.....
4	....	.....	.....	.....	.....	.....	.....	.....	4	.....	.....

I certify that the above account is correct and just.

....., *Ass't Engineer.*

I certify that the above account is correct and just; the articles to be (or have been) accounted for in my return for the quarter of 18 .

(Put only one item on each line.)

....., *Corps of Engineers.*

* This voucher is used when a number of purchases of small amount are to be made, as for fresh provisions for field parties etc.

Pay-Roll.

[FORM NO. 12.]

APPROPRIATION FOR.....

We, the subscribers, hereby acknowledge to have received of , Corps of Engineers, the sums herein specified opposite our respective names, being in full for our services at , during the month of , 189 , having signed duplicate receipts.

Number.	Names.	Occupation.	Time Employed.		Inclusive Dates.		Rate of Pay.		Amount Due.		Number.	Signatures.	Witnesses.	No. of Check.	Date, 189 .	Name of Depositary.	Amount.	
			Months	Days of 8 Hrs. Each.	From—	To—	Per Month.	Per Day of 8 Hrs.	Dolls.	Cts.							Dolls.	Cts.
1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....
2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	.....
3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	.....	.....	.....	.....	.....	.....	.....
etc.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	etc.	.....	.....	.....	.....	.....	.....	.....

I certify that the above Pay-roll is correct and just, and the "Days" for which payments have been made were days of eight hours each.

.....

....., *Corps of Engineers.*

QUARTERMASTER'S DEPARTMENT FORMS.*

[FORM NO. 75.]

CIRCULAR—PROPOSAL.

Office of..... Quartermaster.....

.....

.....18

SEALED PROPOSALS, in duplicate, subject to the usual conditions, will be received at this office until , 18 , at which time and place they will be opened in the presence of bidders, for furnishing and delivering at or at the post of the articles named below.

Proposals for delivery at other points will also be entertained.

BIDDERS MUST STATE THE TIME WHEN, AND THE PLACE WHERE, they propose to make deliveries.

Proposals for either class of stores mentioned, or for quantities less than the whole required, will be received, and the quantities specified may be increased or reduced to the extent of 20 per cent, should the interest of the public service demand such change.

Preference will be given to articles of domestic production or manufacture, conditions of quality and price (including in the price of foreign productions or manufactures the duty thereon) being equal, and such preference will be given to articles of American production and manufacture produced on the Pacific coast to extent of consumption required by the public service there.

The Government reserves the right to reject any or all bids.

Proposals must be signed by the bidder, inclosed in sealed envelopes, addressed to the undersigned, and marked "Proposals for Quartermaster's Stores, to be opened , 18 ."

....

..... *Quartermaster*..... *U. S. Army.*

.....

SIR: In accordance with the above advertisement, inviting proposals for Military Supplies, and subject to all the conditions thereof, propose to furnish and deliver at the articles below specified, at the prices set opposite each article.

.....

* For regulations and instructions relating to these forms see Chapter II.

Form of Proposal, with Guarantee, Justification of Guarantors, and Certificate.

[FORM NO. 74.]

PROPOSAL FOR.....

.....

.....189 .

To.....

.....

.....

SIR: In accordance with your advertisement of , 189 , inviting proposals for and subject to all the conditions and requirements thereof, and of your dated , 189 , copies of both of which are hereto attached, and, so far as they relate to this proposal, are made a part of it, propose to

make this proposal with a full knowledge of the kind, quantity, and quality of the articles required, and, if it is accepted, will, after receiving written notice of such acceptance, enter into contract within the time designated in the advertisement, with good and sufficient sureties for the faithful performance thereof.

Signature, ...
Address, ...
Signature, ...
Address, ...
(Signed in triplicate.)

GUARANTEE TO THE ABOVE BID.

We, , of , in the State of and , of , in the State of , hereby guarantee and bind ourselves and each of us, our and each of our heirs, executors, and administrators, to the effect that if the bid of herewith accompanying, dated , 189 , for shall be accepted in whole or in part within sixty (60) days from the date of the opening of proposals, the said bidder , will, within days after being notified of such acceptance, enter into a contract with the United States in accordance with the terms and conditions of the advertisement, and will give bond with good and sufficient sureties for the faithful and proper fulfillment of the same. And in case the said bidder shall fail to enter into contract within the said days with the proper officer of the United States, and furnish good and sufficient bond for the faithful performance of the same according to the terms of said bid and advertisement, we and each of us hereby stipulate and guarantee, and bind ourselves and each of us, our and each of our heirs, executors, and administrators, to pay unto the United States the difference in money between the amount of the bid of the said bidder and the amount for which the proper officer of the United States may contract with another party to furnish said , if the latter amount be in excess of the former, for the whole period covered by the proposal.

WITNESSES:

.... [SEAL.]
.... [SEAL.]

Dated.....

(Executed in duplicate.)

STATE OF }
County of } *ss:*

I, one of the guarantors named in the within guarantee, do swear that I am pecuniarily worth the sum of dollars over and above all my debts and liabilities.

.....

Before me,

.....

I, do hereby certify that , the surety above named, is personally known to me, and that, to the best of my knowledge and belief, he is pecuniarily worth, over and above all his debts and liabilities, the sum stated in the accompanying affidavit subscribed by him.

.....

STATE OF }
County of } *ss:*

I, , one of the guarantors named in the within guarantee,

do swear that I am pecuniarily worth the sum of dollars over and above all my debts and liabilities.

.....

Before me,

.....

I, do hereby certify that , the surety above named, is personally known to me, and that, to the best of my knowledge and belief, he is pecuniarily worth, over and above all his debts and liabilities, the sum stated in the accompanying affidavit subscribed by him.

.....

Form of Ordinary Contract.

[FORM NO. 66.]

Articles of Agreement entered into this day of , eighteen hundred and , between , Quartermaster , United States Army, of the first part, and , of the county of , of of the second part.

This Agreement witnesseth, That the said , for and in behalf of the United States of America, and the said , for , heirs, executors, and administrators, have mutually agreed, and by these presents do mutually covenant and agree, to and with each other, as follows, viz.:

ARTICLE 1. That the said

ARTICLE . That deliveries on this contract shall, if required, commence on the day of , eighteen hundred and , provided that the agreement is approved by the proper authorities of the War Department; otherwise, not until such approval is obtained.

ARTICLE . That it is expressly agreed and understood that this contract shall be non-effective until an appropriation adequate to its fulfillment is granted by Congress and is available.

ARTICLE . That for and in consideration of the faithful performance of the stipulations of this agreement the part of the second part shall be paid, at the office of the , at , as follows:

ARTICLE . That in case of failure of the said part of the second part to comply with the stipulations of this contract according to the true intent and meaning thereof, then the party of the first part shall have the power to

ARTICLE . Neither this contract nor any interest therein shall be transferred by the said to any other party or parties, and any such transfer shall cause the annulment of the contract so far as the United States is concerned; all rights of action, however, for any breach of this contract by the said are reserved to the United States.

ARTICLE . No member of or delegate to Congress, nor any person belonging to or employed in the military service of the United States, is or shall be admitted to any share or part of this contract, or to any benefit which may arise herefrom.

In witness whereof, the undersigned have hereunto placed their hands and seals the date first hereinbefore written.

WITNESSES:

.... [L. S.]

.....*Quartermaster*....., *U. S. A.*

.... [L. S.]

.... [L. S.]

.... [L. S.]

.... [L. S.]

(Executed in quintuplicate.)

[Endorsement.]

APPROVED:

....., *Quartermaster-General, U. S. A.*

WAR DEPARTMENT,

Quartermaster-General's Office,

.....

☞ To be made in quintuplicate, and disposed of as directed in Par. 654, A. R., 1889.

All contracts must be sealed with wax or other adhesive substance.

Erasures, interlineations, or other irregularities must be explained over signatures and seals of the parties to the instrument.

Form of Contract for Construction Work.

[FORM No. 96.]

CONSTRUCTION BLANK.

Articles of Agreement entered into this day of , eighteen hundred and , between , Quartermaster , United States Army, of the first part, and , of the county of , , of , of the second part.

This Agreement witnesseth, That the said , for and in behalf of the United States of America, and the said , for , heirs, executors, and administrators, have mutually agreed, and by these presents do mutually covenant and agree, to and with each other, as follows, viz.:

ARTICLE 1. That the said

ARTICLE . That work on this contract shall commence on or before the day of , eighteen hundred and , shall be carried forward with reasonable despatch, and be completed on or before the day of , eighteen hundred and .

ARTICLE . That for and in consideration of the faithful performance of the stipulations of this agreement the part of the second part shall be paid, at the office of the , at as follows: for , the total sum of , Payments to be made at such times and in such amounts as the officer in charge of the work may elect, based upon estimates to be made by him of completed work; and in all payments twenty (20) per centum of each to be retained until the final completion and acceptance by the Government of the work under contract.

ARTICLE . That in case of failure of the said part of the second part to comply with the stipulations of this contract according to the true intent and meaning thereof, then the party of the first part shall have the power to complete the work at the expense of the part of the second part in such manner as the party of the first part shall deem best for the interests of the public service, either by day's labor and open-market purchase of the necessary material, or by contract, or both, and any excess of cost resulting from such failure shall be charged to the part of the second part.

ARTICLE . Neither this contract nor any interest therein shall be transferred by the said to any other party or parties, and any such transfer shall cause the annulment of the contract so far as the United States is concerned; all rights of action, however, for any breach of this contract by the said are reserved to the United States.

ARTICLE . No member of or delegate to Congress, nor any person belonging to or employed in the military service of the United States, is or shall be admitted to any share or part of this contract, or to any benefit which may arise herefrom.

ARTICLE . This contract shall be subject to the approval of the Quartermaster-General, U. S. Army.

In witness whereof, the undersigned have hereunto placed their hands and seals the date first hereinbefore written.

WITNESSES:

.... [L. S.]
....., *Quartermaster*....., *U. S. A.*
.... [L. S.]
.... [L. S.]
.... [L. S.]
.... [L. S.]

(Executed in quintuplicate.)

[Endorsement.]

APPROVED:

....., *Quartermaster-General, U. S. A.*

WAR DEPARTMENT,

Quartermaster General's Office,

....

☞ To be made in quintuplicate, and disposed of as directed in Par. 654, A. R., 1889.

All contracts must be sealed with wax or other adhesive substance.

Erasures, interlineations, or other irregularities must be explained over signatures and seals of the parties to the instrument.

Contractor's Bond.

[FORM NO. 76.]

BOND.

Know all men by these presents, That we, , as principal , and of in the county of , and of , and , of , in the county of and of , as sureties, are held and bound unto the United States of America in the penal sum of ($) dollars, to the payment of which sum, well and truly to be made, we do bind ourselves, our heirs, executors, and administrators, jointly and severally, firmly by these presents.

Given under our hands and seals this day of , eighteen hundred and ninety

The condition of this obligation is such, that whereas the above-bounden ha , on the day of , one thousand eight hundred and ninety , entered into a contract with for

Now, therefore if the above-bounden heirs, executors, and administrators, shall and will, in all respects, duly and fully observe and perform all and singular the covenants, conditions, and agreements in and by the said contract agreed and covenanted by to be observed and performed, and according to the true intent and meaning of the said contract, and as well during any period of extension of said contract that may be granted on the part of the United States as during the original term of the same, including the covenant that the said shall be responsible for and pay all liabilities incurred for labor and material in fulfillment of said contract, then the above obligation shall be void and of no effect; otherwise to remain in full force and virtue.

WITNESSES:

.... [L. S.]
.... [L. S.]
.... [L. S.]
.... [L. S.]
.... [L. S.]
.... [L. S.]

(Executed in duplicate.)

STATE OF
County of } *ss:*

I, , one of the sureties named in the within bond, do swear that I am pecuniarily worth the sum of dollars over and above all my debts and liabilities.

....

Before me,

.....

I, , do hereby certify that , the surety above named, is personally known to me, and that, to the best of my knowledge and belief, he is pecuniarily worth, over and above all his debts and liabilities, the sum stated in the accompanying affidavit subscribed by him.

.....

STATE OF
County of } *ss:*

I, , one of the sureties named in the within bond, do swear that I am pecuniarily worth the sum of dollars over and above all my debts and liabilities.

.....

Before me,

.....

I, , do hereby certify that , the surety above named, is personally known to me, and that, to the best of my knowledge and belief, he is pecuniarily worth, over and above all his debts and liabilities, the sum stated in the accompanying affidavit subscribed by him.

.....

[FORM NO. 10½.—Voucher to Abstract A.]

THE UNITED STATES,

To , Dr.

....., ..., ...
[Place of business or residence.] [City or town.] [State or Territory.]

DATE OF PURCHASE.		DOLLARS.	CTS.
	Under public notice of ten days or more and sealed proposals opened , 189 Copy of public notice filed Accepted proposals filed Copy of letter accepting proposals filed		

I certify that the above account is correct and just, and that the articles have been accounted for on my property return for the quarter ending on the of , 189 ; that they were purchased after public advertisement by posters and circulars; that the needs of the service required the purchase to be made in the manner indicated by the public notice, and that the award was made to the lowest responsible bidder for the best and most suitable article.

.....

.....*Quartermaster*, ...

Received, at , the of , 189 , of , Quartermaster U. S. Army, the sum of dollars and cents, in full of the above account.

.....

(Signed in duplicate.)

To be made in duplicate: one copy to be retained by the officer, one to be forwarded to the Quartermaster General with Abstract A.

The authority for making a purchase and a statement of the object and necessity for the same must accompany the voucher. If such authority has already been filed, it should be referred to in all subsequent vouchers for purchases under it.

(See paragraph 717, Army Regulations, 1889.)

[Form No. 32.—Voucher to Abstract D.]

The United States,

To....., Dr.

PLACE AND DATE OF PURCHASE.		DOLLARS.	CTS.

I certify, on honor, that the above account is correct and just; that I purchased the articles above enumerated of the said at the price therein charged, amounting to dollars and cents, and that I have not paid the account.

....., *Quartermaster.*

(Signed in duplicate.)

Property Purchased and not Paid for by End of Quarter.

To be in duplicate: one copy to be retained by the officer, one to be forwarded, with Abstract D, within twenty days after the end of the quarter, to the Quartermaster General.

[Form No. 13.—Voucher to Abstract B.]

The United States,

To....., Dr.

PLACE AND DATE.		DOLLARS.	CTS.

I certify that the above account is correct and just; that the services were rendered as stated; that they were necessary for the public service, and are borne on my report of persons, etc., for the month of , 18 .

.....

.....

Received, at , the day of , 18 , of Quartermaster , United States Army, the sum of dollars and cents, in full of the above account.

.....

(Signed in duplicate.)

To be in duplicate: one copy to be retained by the officer, the other to be forwarded to the Quartermaster-General with Abstract B.

This form is used for payment of services not entered on the receipt-rolls, for rent of buildings, and for other miscellaneous disbursements.

When a man is discharged without being paid, his account will be stated on this form, certified, and given to him.

(See paragraph 1311, Army Regulations, 1889.)

Pay-Roll.

[FORM No. 12.—Voucher to Abstract B.]

We, the subscribers, do hereby acknowledge to have received of Quartermaster , U. S. Army, at the sums set opposite our names, respectively, being in full of our pay for the period herein expressed, having signed duplicates hereof.

Date.	No.	Name.	Rank.	Occupation.	Period of Service.				Rate of Pay.			Amount of Pay.		Amount of Stoppages.		Amount Received.		Signers' Names.	Witnesses.	Remarks.*
					From—	To—	Months.	Days.	Dollars.	Cents.	Per month or day.	Dollars.	Cents.	Dollars.	Cents.	Dollars.	Cents.			
.....	1	.....	.....	.....	.....	.....	....	....	....	....	....	....	....	....	....	....	....	.....	.....	.....
.....	2	.....	.....	.....	.....	.....	....	....	....	....	....	....	....	....	....	....	....	.....	.....	.....
.....	etc.	.....	.....	.....	.....	.....	....	....	....	....	....	....	....	....	....	....	....	.....	.....	.....

I certify, on honor, that the above Receipt Roll is correct and just, and that the services are borne on my Form for the month of , 18 .

.....

....., *Quartermaster*.....

(Signed in duplicate.)

To be made in duplicate: one copy retained by officer, one transmitted to the Quartermaster-General, with Abstract B, within ten days after the end of the month. Civilians and extra-duty men (soldiers) should be paid on separate rolls.

LIGHT-HOUSE ESTABLISHMENT FORMS.†

ADVERTISEMENT.‡

OFFICE OF THE LIGHT-HOUSE ENGINEER, DISTRICT,

....., 1893.

Sealed proposals will be received at this office until 2 o'clock P.M. of , the day of , 189 , for furnishing materials and labor of all kinds necessary for

Plans, specifications, forms of proposal, and other information may be obtained on application to this office.

The right is reserved to reject any or all bids and to waive any defects.

.....

of Engineers, U. S. Army, Light-House Engineer, District.

General Form of Proposal.

BID.

(DATE:).....

....., 1893.

I (or we), , of the , State of engaged in business under the name and style of hereby agree to furnish all the materials and labor necessary to , in strict accordance with the accompanying advertisement, instructions to bidders, specifi-

* When work is performed on Sundays, or overtime, it should be stated in this column.

† For regulations and instructions relating to these forms, see Chapter IV.

‡ The Advertisement Specifications, Instructions to Bidders, Bid, Contract, Bond with Contract, Bondsmen's Oaths, Certificate of Solvency, and Directions as to Execution of Contracts are printed and bound into one pamphlet form.

cations, and drawings, for the sum of dollars ($ $\frac{}{100}$).

The work to be completed and delivered within

(Signature:).....

(Address:).....

(Signature:).....

(Address:).....

To.....

.....

CONTRACT.

N.B.—In executing this contract the directions on the last page* should be carefully followed.

Articles of Agreement, made and entered into between of the first part, and acting for and in behalf of the United States of America, of the second part, witnesseth:

That the party of the first part, in consideration of the matters hereinafter referred to and set out, and of the specifications attached hereto, and forming a part of this contract, covenants and agrees, to and with the party of the second part,

And the said party of the first part further agrees to forfeit the sum of ($) per day for each and every day's delay in after said date, the said forfeiture to be enforced in the discretion of the Secretary of the Treasury, and the amount thereof to be deducted from any sum which might be due the said party of the first part in the hands of the Light-House Establishment, and to conform in every particular to the stipulations and conditions stated in this contract, and to the specifications hereto annexed, which are to be considered as a part of the same, and to be governed in all matters regarding said by the said party of the second part, or the authorized agent or agents thereof; and that the said shall be subjected to a rigid inspection to be made by the party of the second part, or its agents or agents, and that this inspection shall be final.

---

* See Chap. IV, p. 113.

And the said party of the second part covenants and agrees to pay the party of the first part, in full payment for said , as follows :

And it is expressly understood and agreed that, as each payment hereinbefore stipulated is made, possession of the material, labor, and articles which are paid for by such payment shall pass to, and the title thereto shall be vested in, the United States.

Provided, however, that in case the party of the second part shall at any time be of opinion that this contract is not being duly complied with by the party of the first part, or that it is not in due progress of execution, or that the said party of the first part is dilatory or negligent, in such case he, the said party of the second part, shall be authorized to declare this contract forfeited, and thereupon the same shall become null; but the party of the first part shall remain liable to the party of the second part for the damages occasioned to him by the said non-compliance, delay, or negligence.

And it is further stipulated and agreed that no member of Congress shall be admitted to any share or part of this contract or agreement, or to any benefit to arise therefrom; and this contract shall be in all its parts subject to the terms and conditions of sections 3739, 3740, and 3742 of the Revised Statutes of the United States.

And it is also expressly understood and provided that nothing herein contained shall be so construed as to authorize any officer or agent of the United States to bind the United States by contract beyond the amount appropriated by Congress.

And it is further covenanted and agreed that no member of the Light-House Board, inspector, light-keeper, or other person in any manner connected with the Light-House Service, shall be interested, either directly or indirectly, in this contract, or be entitled to any benefit to arise therefrom; and for any violation of this covenant and agreement the party of the first part shall forfeit all moneys which may become due under this contract.

Provided, also, that it is expressly understood and agreed that this contract, or any part thereof, shall not be sublet nor assigned, but that it shall be well and truly carried out and fulfilled in good faith by the above-recited party of the first part, and that payment on account thereof shall be made to the aforesaid party of the first part, successors, heirs, executors, or administrators.

And provided further, that this contract shall not be binding upon

the United States until it shall have been approved by the Light-House Board.

And for the true and faithful performance of all and singular the covenants, articles, and agreements hereinbefore particularly set forth, the subscribers hereunto bind themselves, jointly and severally, their and each of their successors, heirs, executors, and administrators.

Thus covenanted, made, and agreed by the said parties, this day of , anno Domini one thousand eight hundred and ninety , as witness their hands

Signed and delivered in presence of—

....
....
....
....
....

NOTE.—The sureties must *not* sign the contract.

BOND WITH CONTRACT.

Know all men by these presents, That we, , as sureties, are held and firmly bound unto the United States of America in the sum of dollars ($), lawful money of the United States, to be paid to the said United States, or its authorized agent, as liquidated damages; for which payment, well and truly to be made, we, and each of us, do bind ourselves, and each of our successors, heirs, executors, and administrators, jointly and severally, firmly by these presents.

Sealed with our seals, dated this day of one thousand eight hundred and ninety .

The condition of the above obligation is such, that if the said successors, heirs, executors, or administrators, shall well and truly execute the contract hereto annexed, which ha entered into with for and in behalf of the United States, by which covenant and agree to according to all the conditions of the said contract, and shall promptly make payments to all persons supplying said labor and materials in the prosecution of the work provided for in such contract, then this obligation to be void; otherwise, to remain in full force and virtue.

Signed and sealed in the presence of—

WITNESSES:

.... [L. S.]
.... [L. S.]
.... [L. S.]
.... [L. S.]
.... [L. S.]

NOTES.—If the contract be made by an incorporated company, the corporate seal should be impressed on, or affixed to, each copy of both the contract and the bond, and a certificate, under the corporate seal of the company, showing that the person who signs in its behalf is, at the time of signing, the officer he purports to be, and as such is duly authorized to sign sealed instruments in behalf of the company, should be affixed to at least one copy of the contract.

All signatures of sureties should have affixed to them adhesive seals, and their names should be written in full.

The residence of sureties and witnesses should be given.

The bondsmen must qualify in the forms following.

The bondsmen must not sign the contract.

BONDSMEN'S OATHS.

STATE OF }
County of } *ss.*

, being duly sworn, deposes and says that he resides at No. street, in the of , in the State of ; and that the value of his property, over and above all debts and liabilities incurred by him, is over dollars ($), and that he is fully responsible for the amount of his obligation in the foregoing bond by him executed.

(Signature of surety.).....

Sworn and subscribed this day of , 189 , before me.

Signature of officer administering oath, with seal, if any. } .... [L. s.]

STATE OF
County of } *ss.*

, being duly sworn, deposes and says that he resides at No. street, in the of , in the State of ; and that the value of his property, over and above all debts and liabilities incurred by him, is over dollars ($), and that he is fully responsible for the amount of his obligation in the foregoing bond by him executed.

(Signature of surety.).....

Sworn and subscribed this day of , 189 , before me.

Signature of officer administering oath, with seal, if any. } ..... [L. S.]

NOTES.—If the affidavits of the sureties be made before a notary public, his seal should be impressed; if made before a justice of the peace, the usual certificate attesting the official character of the magistrate should be appended.

Each surety will qualify in double the amount of the bond.

CERTIFICATE OF SOLVENCY.

I certify that I have made due and diligent personal inquiry as to the ability of the signers of the foregoing bond, and am satisfied that they are good and sufficient and fully responsible for the sum of ($) each.

(Signature of certifying official.).....

Date, , 189 .

NOTE.—The sureties' certificate of solvency must be signed by an officer of the Government known to the Treasury Department.

LIGHT-HOUSE BOARD, FORM 4*a*. } GENERAL VOUCHER. ORIGINAL.

(To be forwarded with accounts to the Light-House Board.)

U. S. LIGHT-HOUSE ESTABLISHMENT,

To....., Dr.

(Appropriation for.....)

Date of Delivery of Articles or Completion of Service.	DESIGNATION.	APPLICATION.	AMOUNT. Dollars.	Cts.
Contract dated 189 .				

Authorized by Board's letter dated 189 .

I certify that the exigencies of the service required the immediate delivery of the articles and the performance of the services above-mentioned, and that it would have been detrimental to the interests of the Government to have procured the articles and services enumerated by contract. They were therefore purchased in open market upon the best terms obtainable, the prices paid being reasonable, and not in excess of the current market rates. The articles have been received and the services performed.

.....

.....U. S.....,

Light-House

RECEIVED, at , this day of 189 , of , the sum of $\frac{}{100}$ dollars, in full of the above account.
$

(Signed in duplicate.).....

N. B.—This receipt must be signed only by the person in whose favor the voucher is drawn.

Details of price, quantity, time, and rates must always be given, and the purpose to which the articles or labor are applied must be distinctly specified.

Paid by Check No. , dated , 189 , on , at , for $

LIGHT-HOUSE BOARD, FORM 6. SALARY VOUCHER. ORIGINAL.

(To be forwarded with accounts to the Light-House Board.)

U. S. LIGHT-HOUSE ESTABLISHMENT,

To....., Dr.

(Appropriation for.....)

DATE WHEN BILL RENDERED.		DOLLARS.	CTS.
189 .	For services as from the day of to the day of , 189 , inclusive, at $ per		

I hereby certify that the above account is correct and just, and that the expenditure was necessary for the service of the Light-House Establishment.

.....

.....

RECEIVED, at , this day of , 189 , of , the sum of $\frac{}{100}$ Dollars, in full of the above account. $

(Signed in Duplicate.).....

N. B.—This receipt must be signed only by the person in whose favor the voucher is drawn.

Paid by Check No. , dated , 189 , on , at , for $

[LIGHT-HOUSE BOARD, FORM 7*a*.]

PAY-ROLL OF PERSONS EMPLOYED.....

(Appropriation for .) .)

We, the subscribers, hereby acknowledge to have received of , Light-House District, the sums herein specified opposite our respective names, being in full for our services at , during the month of , 189 , having signed duplicate receipts.

Number.	Names.	Occupation.	Period of Service. From—	To—	Months.	Days.	Hours.	Rate of Pay. Dollars.	Cents.	Per Month, Day, or Hour.	Amount Received. Dollars.	Cents.
1	.....	.....	.....	.....	....	....	....	....	....	.....	.....	.....
2	.....	.....	.....	.....	....	....	....	....	....	.....	.....	.....
3	.....	.....	.....	.....	....	....	....	....	....	.....	.....	.....
etc.												

Number.	Signatures.	Witnesses.	No. of Check	Date 189	Name of Depositary.
1	....	.....	.....	....	.....
2	....	.....	.....	....	.....
3	....	.....	.....	....	.....
etc.					

The amount of this roll is $\frac{}{100}$ dollars $

I hereby certify that the above-named and rated persons have been attached to and performed duty under my charge for the periods of time and rates of authorized compensation, respectively, set opposite their names.

....

Light-House..... .....District.

SUPERVISING ARCHITECT'S OFFICE FORMS.*

Form of Advertisement and Proposals for a Custom-house and Post-office.

(The full form comprises the Advertisement, General Instructions and Conditions (see Chapter V, p. 142), the Specifications, and the Proposal.)

PROPOSALS FOR THE ERECTION AND COMPLETION (EXCEPT HEATING APPARATUS) OF THE UNITED STATES CUSTOM-HOUSE AND POST-OFFICE BUILDING AT HOULTON, MAINE.

TREASURY DEPARTMENT,
OFFICE OF THE SUPERVISING ARCHITECT, WASHINGTON, D. C.,
May 22, 1893.

SEALED PROPOSALS will be received at this office until 2 o'clock P.M. on the 14th day of June, 1893, and opened immediately thereafter, for all the labor and materials required for the Erection and Completion (except heating apparatus) of the U. S. Custom-house and Post-office building at HOULTON, MAINE, in accordance with the drawings and specification, copies of which may be had at this office or the office of the Superintendent at Houlton, Maine. Each bid must be accompanied by a certified check for a sum not less than 2% of the amount of the proposal. The right is reserved to reject any or all bids or to waive any defect or informality in any bid if it be deemed in the interest of the Government to do so. All bids received after the time stated will be returned to the bidders. PROPOSALS must be enclosed in envelopes, sealed, and marked "Proposal for the Erection and Completion (except heating apparatus) of the U. S. Custom-house and Post-office building at HOULTON, MAINE," and addressed to Jeremiah O'Rourke, Supervising Architect.

N. B.—The regulations of the Department strictly prohibit the consideration of bids received after the time of opening stated in the advertisement. Bidders are, therefore, requested to allow ample time for the transmission of their bids by mail. Registered letters usually reach this office at least 24 hours behind the regular mail.

PROPOSAL FOR THE ERECTION AND COMPLETION OF THE UNITED STATES CUSTOM-HOUSE AND POST-OFFICE BUILDING AT HOULTON, MAINE (EXCEPT HEATING APPARATUS), INCLUDING APPROACHES.

, 1893.

Mr. JEREMIAH O'ROURKE,
Supervising Architect,
Treasury Department, Washington, D. C.

SIR: hereby propose to furnish all the labor and materials required for the erection and completion of the United States Custom-house and Post-office building at HOULTON, MAINE (except heating apparatus), including the approaches, in strict accordance with drawings Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, miscellaneous drawings 126, 200, 275, 294, the specification , and such other detail drawings as may be furnished, and samples herewith submitted for the sum of $

Granite, name and location of quarry,

Time to complete

Amount included in bid for general excavation, $
Amount included in bid for trench excavation, $
Amount included in bid for grading and seeding lot, $
Amount included in bid for concrete foundations, $
Amount included in bid for stone footings, $
Amount included in bid for granite-work, $
Amount included in bid for press brick facing, $
Amount included in bid for agricultural drain, $
Amount included in bid for common brickwork of building, $
Amount included in bid for brick arches with concrete filling and wood floor-strips over same, and terra-cotta column covering, $
Amount included in bid for concrete floors of basement and area, $
Amount included in bid for all the ironwork of building, including columns, beams, girders, iron railings, lintels, ladders, etc., $
Amount included in bid for carpentry-work, including floor and ceiling joists, stud partitions, furring, roof construction, rough flooring, ladders, roof sheathing, flagstaff, etc., $
Amount included in bid for joiner-work, including finished flooring, skirting, water-closet partitions, post-office screen, shelving, etc., $
Amount included in bid for hardware, $
Amount included in bid for glass, $
Amount included in bid for slate-work of roofs, $
Amount included in bid for galvanized-iron and tin work, $
Amount included in bid for plaster-work, including iron furring and lathing, cornices, architraves, column finish, etc., $
Amount to be added to bid if King's Windsor Cement is substituted for the lime mortar specified, $
Amount included in bid for plumbing, including down-pipes and drain-pipes, iron tanks, all plumbing fixtures, and slate and marble work in connection therewith, and all gas-piping, $

* For the regulations and instructions relating to these forms see Chapter V.

Amount included in bid for painting, $
Amount included in bid for marble floor-tiling, $
Amount included in bid for marble mantels and marble sub-base, $
Amount included in bid for mailing platform enclosure, complete, $
Amount included in bid for iron vault-doors, $
Amount to be deducted from bid if rock is found and the excavation is carried down 11′ 5″ below first-floor line and the trench excavation, concrete foundations, stone footings, and the broken stone and cement base for basement, and area floors are omitted, $
Amount to be deducted from bid if the earthenware sewer is run and connected with sewer company's sewer in Water Street, about 71 feet, instead of sewer on Main Street, about 274 feet, as specified, $
Amount to be added to bid if polished plate glass be substituted for the double thick sheet glass specified, $
Price per cu. yd. for general excavation, $
Price per cu. yd. for trench excavation, $
Price per cu. yd. for concrete foundations, $
Price per cu. ft. for stone footings, $
Price per cu. yd. for earth filling and grading, $
Price per cu. ft. for granite bearing-plates, $
Price per cu. ft. for granite steps, $
Price per cu. ft. for cut and moulded granite, $
Price per M for press facing-brick in wall, $
Price per M for moulded brick in wall, $
Price per M for common brick in wall, $
Price per sq. ft. for brick arches with concrete filling and wood floor-strips, $
Price per sq. ft. for terra-cotta column covering, $
Price per sq. ft. for concrete floors in basement and area, $
Price per pound for cast-iron columns in place, $
Price per pound for iron floor-beams and channels in place, $
Price per pound for iron girders in place, $
Price per sq. ft. for wood floor-construction, including rough flooring, $
Price per sq. ft. for wood roof construction in place, $
Price per square foot for roof sheathing in place, $
Price per square foot for stud partitions, $
Price per square for slate on roof, $
Price per square yard for plaster on walls, $
Price per square yard for King's Windsor Cement on walls, $
Price per square yard for plastering on ceilings, etc., including metal lathing, $
Price as per above for King's Windsor Cement, $
Price per lineal foot for wall cornice, $
Price per lineal foot for girder cornice, $
Price per square foot for marble tiling, $
Price per square yard for brick paving for sidewalks, $
Price per lineal foot for street curbing, $
Price per lineal foot for lot coping, $
Price per lineal foot for driveway curbing, $
Name or brand of cements proposed to be used,
Price per barrel for cement included in estimate, $

Signature .....

Address .....

Members of Firm.

.....

.....

[Treasury Department, Office Supervising Architect.—Form 8.]

BOND FOR ACCEPTED PROPOSAL.

Know all men by these presents, That we of the City of , County of , and State of , principal , and of the City of , County of , and State of , and of the City of , County of , and State of , Sureties, are held and firmly bound unto the United States of America in the sum of dollars ($), lawful money of the United States, to be paid as liquidated damages, for the payment of which, well and truly to be made to the United States, we bind ourselves, our heirs, executors, and administrators, jointly and severally, firmly by these presents.

Sealed with our seals, and dated this day of , 189 .

The condition of the above obligation is such, That whereas the said in accordance with the terms of bearing date , 189 , and drawing , numbered h submitted a proposal, bearing date , 189 , to furnish for the sum of dollars ($), for the United States building, in the city of , County of , and State of to , Supervising Architect of the United States Treasury Department, in the city of Washington and District of Columbia, acting for and in behalf of the United States of America, and which said proposal was accepted by the said by letter bearing date , 189 . Now if the said shall well and truly comply with all of the conditions of each of said papers, a copy of each of which said papers is attached hereto; and shall well and truly comply with the requirements of said numbered drawing , which said numbered drawing , bearing the signature of the said and the signature of the said , on file in the Office of the said , and shall perform all the undertakings therein stipulated by , to be performed, then this obligation shall be void and of no effect; otherwise to be and to remain in full force and virtue.

In testimony whereof, The said have hereunto subscribed their hands and affixed their seals the day first above written.

Signed, sealed, and delivered in the presence of—

(Signatures of two witnesses to signature of principal and signature of each surety.)

..... } ..... [SEAL.]
..... }

..... } ..... [SEAL.]
..... }

..... } ..... [SEAL.]
..... }

..... } ..... [SEAL.]
..... }

(Signatures of principal and sureties.) (Seals of wafer or wax.)

STATE OF }
County of } *ss:*

Personally appeared before me, a in and for said , the said who signed the above obligation, and who made solemn oath that they are each worth dollars ($) over and above their legal liabilities.

Sworn to and subscribed as above written, before me, this day of , 189 .

(Magistrate's signature.) .... (Sureties' signatures.)

....

NOTE.—Sufficiency of sureties should be certified to by the Judge or Clerk of the U. S. District Court, or by the U. S. District Attorney, of the district in which the contractor resides.

OFFICE OF THE U. S.
DISTRICT OF

, A. D. 189 .

I hereby certify, That the sureties who have signed the foregoing bond, are known to me to be residents of and citizens of the United States, and that I believe them to be amply sufficient security for the amount thereof, and that the bond is good.

.....
.....

[ENDORSEMENT.]

TREASURY DEPARTMENT,

Office of the Supervising Architect,

, 189 .

Respectfully referred to the Solicitor of the Treasury for examination and indorsement.

.....

Supervising Architect.

DEPARTMENT OF JUSTICE,

Office of the Solicitor of the Treasury,

, 189 .

I have examined this Bond as to form and execution, and in these respects it is approved.

.....

Solicitor of the Treasury.

TREASURY DEPARTMENT,

Office of the Secretary,

, 189 .

Approved:

.....

Secretary.

No.....

BOND FOR ACCEPTED PROPOSAL OF

.....

Of
For
For U. S.
At
Dated , 189 .
Bond, $
Proposal dated , 189 .
Amount of proposal, $
Proposal accepted , 189 .
Time to complete from date of letter accepting proposal.
Penalty for each day's delay beyond time stipulated for completion, $

INSTRUCTIONS TO BE FOLLOWED IN THE EXECUTION OF THIS BOND.

1. The christian and surname must be written in the body of the bond and so signed to the same.
2. A seal of wax or wafer must be attached to each signature.
3. Each signature must be attested by two witnesses.
4. The affidavit of the sureties must be made and signed before an officer authorized to administer oaths generally, who should certify that he administered the oaths. If not a judge of an United States court, the authority of such officer to administer oaths should be certified by the clerk of a court of record under seal of said court.
5. The sureties must justify in amounts the aggregate of which will be equal to double the penal sum of the bond.
6. A district judge, or attorney of the United States, or clerk of an United States court must certify that the sureties have sufficient property to pay the penalty of the bond.
7. When executed by a corporation, the officer acting on its behalf should attach the seal of the corporation to his signature, and furnish a certificate that he has been duly elected as such officer, and has authority to bind the corporation. This certificate should be made under the seal of the corporation, if it has one, or before an officer authorized to administer oaths. When executed by a firm each member should sign the bond.

Form of Contract, Bond, Justification of Sureties, and Certificate.

[TREASURY DEPARTMENT, OFFICE OF THE SUPERVISING ARCHITECT. FORM 36.]

CONTRACT* BETWEEN THE UNITED STATES OF AMERICA and

Whereas, in accordance with law, by duly published notice, a copy whereof is hereto annexed, proposals were invited as therein set forth: *Now*, this contract, made and entered into by and between Supervising Architect of the United States Treasury Department, for and in behalf of the United States of America, of the first part, and of the second part, to whom was awarded the contract on bid for the same received under said notice, *Witnesseth:* That the party of the second part covenants and agrees to and with the party of the first part to furnish

The party of the second part further covenants and agrees to execute the work at such times and in such quantities as may be required by the party of the first part it being understood and agreed by and between the parties hereto that if, through any fault of the party of the first part, the party of the second part is delayed in the execution of the work provided for in this contract, and is thereby prevented from completing the same within the time above stated, the party of the second part shall be allowed one additional day to the time above stated for each and every day of such delay as ascertained by the party of the first part. And it is understood and agreed by and between the parties hereto that if the party of the second part shall fail to comply with the terms of this contract which relate to the time within which the said work or parts thereof are to be completed, the said party of the second part shall forfeit the sum of per diem, for each and every day thereafter until the completion of the contract by the party of the second part, subject, however, to the discretion of the Secretary of the Treasury, which sum shall be deducted from any money which may be due and if that amount be not due, then the party of the second part agrees to pay the same.

It is further covenanted and agreed by and between the parties hereto that if the said party of the second part shall fail to prosecute the work herein contracted for with such diligence as in the judgment of the party of the first part will insure the completion of the said work within the time hereinbefore provided, or shall fail to comply with any of the terms of this contract, and thereby, in the judgment of the party of the first part, hazard the satisfactory completion of the work as hereinbefore stipulated, the said party of the first part is authorized and empowered, after eight days' due notice thereof in writing, served personally upon or left at the shop, office, or usual place of abode of the said party of the second part, or with agent, and the said party of the second part having failed to take such action within the said eight days as will, in the judgment of the party of the first part, remedy the default for which said notice

* The copy of the Act approved August 13, 1894, for the protection of persons furnishing materials and labor for construction of public works (see p. 1), is embodied in and becomes a part of all contracts under this office.

was given, to take possession of the said work in whole or in part, and of whatever machinery, tools, or materials belonging to the said party of the second part and employed thereon, and to complete the said work, and to supply the labor, materials, and tools of whatever character necessary to be purchased or supplied by reason of the default of the said party of the second part, and the actual cost thereof shall be deducted from any moneys due or owing to the said party of the second part on account of this contract, and if that amount be not due, then the actual cost thereof shall be repaid to the party of the first part on demand.

And the said party of the first part, acting for and in behalf of the United States, doth covenant, promise, and agree to pay or cause to be paid, unto the said party of the second part, or to

in lawful money of the United States,

in consideration of two herein-recited covenants and agreements made by the party of the second part, the sum of

Payments to be made in the following manner, viz.:

per cent (tenths) of the value of the work executed to the satisfaction of the party of the first part, will be paid from time to time as the work progresses, in monthly payments (the said value to be ascertained by the party of the first part), and per cent (tenth) thereof will be retained until the completion of the entire work, and the approval and the acceptance of the same by the party of the first part, which amount shall be forfeited by said party of the second part in the event of the non-fulfilment of this contract, subject, however, to the discretion of the Secretary of the Treasury; it being expressly stipulated and agreed that said forfeiture shall not relieve the party of the second part from liability to the party of the first part for all damages sustained by reason of any breach of this contract. It is further covenanted and agreed between the parties to this contract, that the party of the second part shall execute, with two or more good and sufficient sureties, a bond to the United States in the sum of , conditioned for the faithful performance of this contract and the agreements and covenants herein made by the said party of the second part. It is an express condition of this contract, that no member of Congress, or other person whose name is not at this time disclosed, shall be admitted to any share in this contract or to any benefit to arise therefrom; and it is further covenanted and agreed that this contract shall not be assigned, and that any assignment thereof shall be a forfeiture of the same. It is further covenanted and agreed by and between the parties hereto, that this contract shall be valid and binding when approved by the Secretary of the Treasury, and not otherwise,

In witness whereof the parties hereto have hereunto subscribed their names this day of , A. D. 18 .

.....

.....

All erasures, alterations and interlineations to be noted here before execution.

Witnesses to the signature of the Supervising Architect and as to this contract being correctly prepared and compared:

Two witnesses.

.....
Chief of the Law and Contract Division.

.....
Chief of the Computers' Division.

.....
Supervising Architect.

Witnesses to the signature of the Contractor:

Two witnesses.

.....

.....

.....
Contractor.

BOND.

Know all men by these presents, That we, of the City of , Connty of and State of , principal , and of the City of , County of and State of , and of the City of , County of and State of , sureties, are held and firmly bound unto the United States of America in the sum of , lawful money of the United States, for the payment of which, well and truly to be made to the United States, we bind ourselves, our heirs, executors, and administrators, jointly and severally, firmly by these presents.

Sealed with our seals, and dated this day of A. D. 18 .

The condition of the above obligation is such, That whereas the said ha entered into a certain contract, hereto attached with , Supervising Architect of the United States Treasury Department, acting for and in behalf of the United States, bearing date the day of A. D. 18 : *Now*, if the said shall well and truly comply with the conditions of said contract, and shall perform all the undertakings therein stipulated by to be performed, then this obligation to be void; otherwise, to remain in full force and virtue.

In testimony whereof the said have hereunto subscribed their hands and affixed their seals the day first above written.

Signed, sealed, and delivered in presence of—

Two witnesses to each signature. ..... } ..... [SEALS.]
..... }

..... } ..... [SEALS.]
..... }

STATE OF
County of } *ss:*

Personally appeared before me, a in and for said , the said who signed the above obligation, and who made solemn oath that they are each worth over and above their legal liabilities.

SWORN TO AND SUBSCRIBED as above written, before me this day of , 18 .

Magistrate's signature. .....

Sureties' signature. .....

OFFICE OF THE U. S.
DISTRICT OF

, A. D. 18 .

I hereby certify, That the sureties who have signed the foregoing bond, are known to me as residents of , and citizens of the United States, and are amply sufficient security for the amount thereof, and that the bond is good.

.....
.....

TREASURY DEPARTMENT,
Office of the Supervising Architect,
....., 18 .

Respectfully referred to the Solicitor of the Treasury for examination and indorsement.

.....
Supervising Architect.

DEPARTMENT OF JUSTICE,
Office of the Solicitor of the Treasury,
....., 18 .

I have examined this contract and bond as to form and execution, and in these respects it is approved.

.....
Solicitor of the Treasury.

TREASURY DEPARTMENT,
Office of the Secretary,
....., 18 .

Approved: .....
Secretary.

VOUCHER.

[SUPERVISING ARCHITECT'S OFFICE.—FORM 12.]

THE UNITED STATES,
To , Dr.

On account of the appropriation for

DATE. 189 .	DESIGNATION.	APPLICATION.	AMOUNT. Dollars.	Cents.

I certify that the articles above enumerated have been received and the services performed; that they were necessary for, and have been, or will be, applied to the construction of the ; and that the prices paid were just and reasonable.

.....

RECEIVED, , this day of , 189 , from , the sum of $\frac{}{100}$ dollars, in full payment of the above account.

$ (Signed in duplicate.) ....

Paid by check on . No. , dated , 189 .

[Treasury Department, Office of the Supervising Architect.—Form 17.]

MECHANICS' AND LABORERS' VOUCHER, NO.

Pay-roll of Mechanics and Laborers on , during the month of , 189 .

We, the undersigned, acknowledge to have received from , Disbursing Agent, the amounts hereunto set opposite our names, respectively, in full payment of our services for the time specified.

No.	Names.	Occupation.	Term of Service.		Number of Days.	Price per Day.		Amount.		Signers' Names.	Witnesses' Names.	Remarks.
			Commencement.	Expiration.		Dolls.	Cts.	Dolls.	Cts.			

I certify that the services charged in the above roll were actually performed, and necessary to the construction of the ; and that the compensations paid were just and reasonable. ....., *Superintendent.*

LIFE-SAVING SERVICE FORMS.*

[Office General Superintendent Life-saving Service.—Form No. 7.]

Proposal for

FOR THE U. S. LIFE-SAVING SERVICE.

Dated at , 1892.

To the Secretary of the Treasury,
Washington, D. C.

Having carefully examined the plans and specifications herewith submitted for the construction of , I (or we), , doing business under the firm-name and style of , will contract to build the said , complete in all respects, according to the terms thereof, on or before the day of , 189 , for the sum of † dollars ($), and do agree to enter into such bonds for the faithful performance of the proposed contract as may be required.

* ..... Residing at
* ..... Residing at
* ..... Residing at
* ..... Residing at

Place of business

Form of Contract, Bond, Justification of Sureties, and Certificate.

[Life-saving Service.—Office Form 14.]

THIS AGREEMENT,* made and entered into by and between part of the first part, and the United States by , party of the second part:

* For the regulations and instructions relating to these forms, see Chapter VI.

† Prices must be written as well as expressed in figures.

* When proposal is made by a firm, the full name of each member thereof should be given.

† The provisions of the Act appd. Aug. 13, 1894, for the protection of persons furnishing materials and labor for construction of public works (see p. 1) are embodied in Contracts and Bonds.

Witnesseth, That the said part of the first part, for and in consideration of the covenants, stipulations, and agreements hereinafter contained, to be kept and performed by the said party of the second part, and the money to be paid hereunder, do hereby covenant and agree to and with the said party of the second part that , the said part of the first part, will furnish the materials required for, and will construct, make, erect, and build life-saving station-house , the exact site therefor to be pointed out and shown to the said part of the first part by some person duly authorized thereto by the Secretary of the Treasury; said life-saving station-house to be completed in all respects agreeably to, and in conformity with, the specifications and plans therefor hereto annexed and forming a part of this contract, and finished ready for the inspection of such person or persons as may be designated for that duty by the Secretary of the Treasury, on or before the

And the said party of the second part, in consideration of the foregoing, and the further stipulations hereinafter contained, to be done and performed by the said part of the first part, doth covenant and agree to and with the said part of the first part, that there shall be paid unto from the Treasury of the United States, in lawful money of the United States, for the above-named house , when built and completed in conformity with the foregoing, and the specifications and plans therefor hereunto appended, the same having been first duly inspected by the properly authorized inspecting officer or officers and found satisfactory, the sum of for said station-house so constructed and completed as herein stipulated: *Provided, however*, that no payment shall be made under this contract until after presentation of accounts in proper form, duly certified, for the amount due, and the examination of the same by the proper accounting officers of the Treasury Department.

And it is further stipulated by and between the parties hereto that during the progress of said work the necessary facilities shall be furnished by the said part of the first part to any person or persons duly authorized by the Secretary of the Treasury for the inspection of said work and of the materials used and employed therein.

And it is further stipulated and agreed by and between the parties hereto that no expense extra the contract shall be incurred, nor shall the United States be held liable for any extra work beyond that stipulated in this contract and the specifications and plans constituting a part thereof, unless the same shall have been first authorized in writing by the Secretary of the Treasury.

And it is further stipulated and agreed by and between the parties hereto that no member of Congress, nor any other officer or employee in the civil, military, or naval service of the United States, shall be admitted to share in this contract or to any benefit to arise therefrom.

And it is further understood and agreed between the parties hereto, that in case of the neglect or failure of the said part of the first part to fulfill the stipulations of part of this contract, then the Secretary of the Treasury is authorized to direct purchases to be made of all the necessary materials, and cause the construction of said house to be completed as herein specified and required, and the said part of the first part shall be liable to the said United States, in such event, for any excess of the cost of said house over the price hereinafter named and stipulated to be paid therefor to said part of the first part.

And it is further stipulated and agreed by and between the parties hereto, that in case of neglect or failure of the said part of the first part to complete the above-mentioned house agreeably to and in conformity with the specifications and plans, and the terms of this contract, on or before the date herein specified for the completion thereof, there shall be deducted the sum of dollars ($) per day from the amount payable hereunder, in the discretion of the Secretary of the Treasury, for each and every day that the completion and erection of said house , as agreed, may be delayed beyond the time specified in this contract, and the said part of the first part shall accept and receive the payment hereinbefore provided, less said sum of dollars ($) per day to be deducted for each and every day's delay, in full payment for the materials furnished and work and labor done and performed under this contract.

And it is further stipulated that the Secretary of the Treasury, whenever in his judgment good and sufficient cause may exist for so doing, shall have the power to annul and revoke all the terms hereby agreed upon, and the said part of the first part shall not be entitled to anything on account of damages sustained through said act of the Secretary of the Treasury.

And for the true and faithful performance of all and singular the covenants, stipulations, and agreements hereinbefore particularly set forth, the part of the first part hereunto bind heirs, executors, administrators, and assigns, jointly and severally; and the party of the second part binds himself and his successors in office firmly by these presents.

As witness their several hands and seals this , A. D. one thousand eight hundred and ninety-

Signed, sealed, and delivered in the presence of—

....
....
....
....
....

....., *Secretary of the Treasury.*

Know all men by these presents, That we, , of in the County of , and State of as principal, and , of in the County of and State of , and , of in the County of and State of , as sureties, are held and firmly bound unto the United States in the full and just sum of dollars ($), lawful money of the United States, for the payment of which sum, well and truly to be made to the United States, we bind ourselves, our and each of our heirs, executors, administrators, and assigns, jointly and severally, firmly by these presents.

Sealed with our seals, and dated this of , A. D. one thousand eight hundred and ninety-

The condition of the foregoing obligation is such, that if the above-bound , or heirs, executors, administrators, and assigns, do and shall well and truly execute the contract hereto annexed, which ha entered into with the United States, whereby the said ha agreed to furnish the materials required for, and construct, make, build and erect, life-saving station-house at conforming in all respects to said contract in all the stipulations, covenants, and agreements therein contained, and the plans and specifications for construction thereto appended, which said contract is annexed hereto, then said obligation to be void and of none effect; otherwise, to be and remain in full force and virtue in law.

Signed, sealed, and delivered in the presence of—

.... [L. S.]
.... [L. S.]
.... [L. S.]
.... [L. S.]

STATE OF
County of } *ss:*

Before me, a in and for said county, personally appeared the said and the sureties named in, and who executed, the foregoing writing obligatory, who, being by me first duly sworn, made oath in solemn form, each for himself, that he is worth the sum of dollars ($) over and above all his several legal liabilities; and the said , for himself, made oath that his property consists of lying in the County of and State of , and the said , for himself, made oath that his property consists of , lying in the County of and State of .

Subscribed and sworn to before me, this day of , 189 . } [SEAL.] ..... } *Signatures of Sureties.*

...., *Notary Public, or Justice of the Peace.*

I hereby certify that , and , the persons named in, and who executed, the foregoing bond as sureties, are to me well known; that they are residents of , and are, in my opinion, good and sufficient sureties for the purposes mentioned in said bond.

..... [SEAL.]

CONTRACT FOR

, 189 .

....., *Contractor.*

TREASURY DEPARTMENT,

Life-saving Service,

, 189 .

Respectfully referred to the Solicitor of the Treasury for examination and indorsement.

....., *General Superintendent.*

DEPARTMENT OF JUSTICE,

Office Solicitor of the Treasury,

, 189 .

I have examined this Contract and Bond as to form and execution, and in these respects they are approved.

....., *Solicitor.*

[Form 1814.]

VOUCHER FOR GENERAL EXPENSES.

The United States, To , Dr.

[Post-office address.]

....., ...

Date Expense was Incurred.	Authorized by Letter dated , 189 .	Dollars.	Cts.	Sub-voucher No.
189 .	*			

[Articles *or* services.] [Received *or* performed.]

ORIGINAL.

certify that the above enumerated have been ; that they have been duly inspected and were delivered and accepted on the day of , 189 ; that they were necessary for, and have been, or will be, applied to the use of the Life-Saving Service; that the prices charged are just and reasonable, and do not exceed current market rates.†

..... } .....
..... } .....
Superintendent.

Appropriation: ..... } Approved :
..... } .....
Assistant Secretary.

Received at , this day of , 189 , of , Disbursing , the sum of $\frac{}{100}$ dollars, in full of the above account.

$ ††.....

Witness: .....,

Paid by check on , No. , dated , 189 , ‡ drawn to the order of.....

* The price per unit of weight or measure should be stated in all cases.

† Insert here "and in all respects according to contract," or "and that the exigency of the service required the immediate ."
[Delivery *or* performance.]

†† To be receipted in black ink in all cases.

‡ This blank to be filled when the bill is in favor of a corporation.

[Form 1814.]

Voucher No.

ORIGINAL VOUCHER OF

....., ...

FOR

.....

$

Appropriation :

United States Life Saving Service.

DISTRICT OF COLUMBIA FORMS.*

Form of Proposals for Materials and Labor.

PROPOSALS FOR SHEET-ASPHALT AND ASPHALT-BLOCK PAVEMENTS.

Office of the Commissioners, D. C.,
Washington, D. C., , 1894.

Sealed Proposals will be received at this office until two o'clock P.M., , 189 , for laying Sheet-asphalt and Asphalt-block Pavements.

Blank forms of proposals, specifications, and all necessary information can be obtained at this office.

John W. Ross,
George Truesdell,
Chas. F. Powell,
Commissioners, D. C.

Proposal.

Washington, D. C., 1894.

Sirs: hereby propose to furnish all necessary material and labor

* For regulations and instructions relating to these forms, see Chapter VII.

(except the granite paving-blocks and curb, paving brick and tile, which are to be furnished by the District government), and in a good, firm, and substantial manner, in strict accordance with the specifications and general stipulations hereto attached, execute such work of improvement on streets, avenues, or alleys in the District of Columbia as may be awarded to by the Commissioners of the District under the appropriations for the fiscal year 1895, at the prices set opposite the several items respectively, and such additional work as may be ordered at prices stated in the specifications.

1. Laying standard asphalt pavement on 6-inch hydraulic base, 2½-inch asphalt surface, 2-inch binder, before compression, at ($) per square yard.

2. Laying standard asphalt pavement on 4-inch hydraulic base, 2½-inch asphalt surface, 2-inch binder, before compression, at ($) per square yard.

3. Laying standard asphalt pavement on cobble, rubble, or macadam base, including preparation of bed, asphalt surface, 2½ inches before compression, at ($) per square yard; asphalt binder at ($) per cubic yard; bituminous base, at ($) per cubic yard.

4. Laying asphalt-block pavement on gravel base, at ($) per square yard.

5. Laying asphalt-block pavement on concrete base, at ($) per square yard.

enclose the receipt of the Collector of the District of Columbia for five thousand (5000) dollars, which have deposited with the Collector to the credit of the Commissioners of the District of Columbia as a guarantee of good faith, and which hereby forfeit as liquidated damages to the District of Columbia in the event of failure to enter into a contract for so much of the work as may be awarded , with good and sufficient sureties, within ten (10) days after notice of the award.

Very respectfully,

.....

.....

.....

TO THE COMMISSIONERS OF THE DISTRICT OF COLUMBIA.

(This is followed by the specifications and the official instructions for bidders.)

Form of Proposals for Materials.

PROPOSALS FOR FURNISHING CAST-IRON WATER-PIPE.

OFFICE OF THE COMMISSIONERS.

WASHINGTON, D. C., July 28, 1894.

SEALED PROPOSALS will be received at this office until 2 P.M., August 11, 1894, for furnishing Cast-iron Water-pipe. Specifications and blank forms may be obtained at this office.

J. W. ROSS,
GEORGE TRUESDELL,
CHAS. F. POWELL,
Commissioners, D. C.

PROPOSAL.

WASHINGTON, D. C., , 1894.

TO THE COMMISSIONERS OF THE DISTRICT OF COLUMBIA.

SIRS: We propose to furnish and deliver, in accordance with the requirements of your specifications, copies of which are hereto attached, ten thousand feet of four (4) inch pipe, for dollars and cents ($) per ton of 2240 pounds; fifty thousand feet of six (6) inch pipe, for dollars and cents ($) per ton of 2240 pounds, and five thousand feet of twelve (12) inch pipe, for dollars and cents ($) per ton of 2240 pounds.

We enclose herewith the receipt of the Collector of the District of Columbia for $100, which we have deposited as a guarantee of good faith, and which we hereby forfeit as liquidated damages to the District of Columbia in the event of our failure to enter into a contract, with good and sufficient sureties, within ten days after notice that the work has been awarded to us.

Very respectfully,

.....

.....

.....

SPECIFICATIONS.

1. *Work.*—The work will consist in furnishing and delivering 10,000 feet of 4-inch, 50,000 feet of 6-inch, and 5000 feet of 12-inch cast-iron water-pipe. Bids for the whole or any part will be considered. The right is reserved to increase the amount of the order by not to exceed one third.

2. *Patterns.*—All patterns are to be furnished by the contractor and approved by the Engineer.

3. *Metal.*—The metal of which the pipes are to be made shall be of such make as shall be approved by the Engineer. It shall be without any admixture of cinder iron or other inferior metal, entirely free from uncombined carbon, when seen under the microscope, and shall admit of being easily drilled or cut; test castings of special pattern shall be made when required, and must stand a tensile strain of 18,000 pounds per square inch.

4. *Workmanship.*—The pipe shall be circular cylinders, with concentric inner and outer surfaces, free from defects, smooth in the bore, and true to dimensions. No pipe will be accepted whose eccentricity, at either bell or spigot end, exceeds $\frac{1}{8}$ inch.

5. *Thickness and Weight.*—The 4-inch pipe shall be $\frac{3}{8}$ of an inch thick, weight 216 pounds per length; 6-inch pipe, thickness $\frac{7}{16}$ of an inch, weight 363 pounds; 12-inch pipe, thickness $\frac{9}{16}$ of an inch, weight 900 pounds. Permitted variation of weight, 3 per cent. No pipe will be received when its thickness at any part is found less by more than $\frac{1}{16}$ of an inch than that specified. No payment will be allowed for any excess of weight above the permitted variation.

(This is followed by the specifications and by the official instructions for bidders.)

Contract.

No.....

THIS CONTRACT,

Made and concluded this day of in the year of our Lord one thousand eight hundred and ninety- by and between the District of Columbia, of the first part, and of the second part—

Witnesseth;

FIRST. That the said part of the second part or other legal representatives, ha agreed, and by these presents do agree, with the said party of the first part, for the consideration hereinafter mentioned and contained, and under the penalty expressed in a bond bearing even date with these presents, and hereunto annexed, to furnish all necessary labor and material, except as otherwise herein provided, and in a good, firm, and substantial manner, in strict accordance with the specifications and general stipulations hereunto attached and made a part of this contract, execute the following described work, to wit:

In witness whereof, The undersigned, JOHN W. ROSS, GEORGE TRUESDELL, and CHARLES F. POWELL, Commissioners of the District of Columbia, appointed under the Act of Congress entitled "An act providing a permanent form of government for the District of Columbia," approved June 11th, 1878, and the part of the second part to these presents have hereunto set their hands and seals the day and year first above written.

..... [SEAL.]
..... [SEAL.]
..... [SEAL.]
Commissioners of the District of Columbia.

..... [SEAL.]
..... [SEAL.]
..... [SEAL.]

Signed and sealed in the presence of—

.....
.....
.....

General Form for Bond.

Know all men by these presents, That we, as principal , and as sureties, all of the District of Columbia, are held and firmly bound unto the United States of America in the sum of dollars, lawful money of the United States of America, to be paid to the said United States, for which payment well and truly to be made, we and each of us do bind ourselves, and each of

our heirs, executors, and administrators, jointly and severally, firmly by these presents.

Sealed with our seals. Dated this day of A. D. one thousand eight hundred and ninety- .

Whereas, The above bounden or other legal representatives, by an instrument in writing under hand and seal bearing even date with these presents contracted with the District of Columbia to furnish all necessary labor and materials, except as therein otherwise provided, and in a good, firm, and substantial manner, in strict accordance with the terms, conditions, and provisions of the foregoing contract , execute the work of

on the conditions and for the considerations in the aforesaid contract, mentioned and contained, or referred to therein.

Now, Therefore, The conditions of the foregoing obligation are such, that if the said or other legal representatives shall strictly and faithfully perform, to the satisfaction and acceptance of the Commissioners of the District of Columbia, the work to be done by the said in accordance with the stipulations of said contract, and shall save harmless from and indemnify the District of Columbia for any and all claims, suits, costs, charges, counsel fees and judgments for damages, to which said District may be subjected on account of any accident to persons, property, or premises, after the commencement of the work, and prior to its completion and acceptance, and pay the same, and in every respect fully comply with the provisions and requirements of said contract, and keep the work done by the said under said contract in repair for the term of five years from the completion of said contract, then this obligation to be void; otherwise to remain of full force and virtue.

Signed and sealed in the presence ..... [L. S.]
of ..... [L. S.]
.... [L. S.]
.... [L. S.]
.... [L. S.]
..... [L. S.]

Approved:

.....
.....
.....

Commissioners, D. C.

Form for Special Bond, No. 2.

Know all men by these presents, That we of are held and firmly bound unto the District of Columbia, in the sum of dollars, lawful money of the United States of America, to be paid to the said District of Columbia, for which payment well and truly to be made, we and each of us do bind ourselves, and each of our heirs, executors, and administrators, jointly and severally, firmly by these presents.

Sealed with our seals. Dated this day of A. D. one thousand eight hundred and ninety .

Whereas, The above bounden or other legal representatives, by an instrument in writing under hand and seal , bearing even date with these presents contracted with the District of Columbia to furnish all necessary labor and materials, except as therein otherwise provided, and in a good, firm, and substantial manner, in strict accordance with the terms, conditions, and provisions of the foregoing contract , execute the work of

And, Whereas, the said in the fulfillment of the aforesaid contract with the District of Columbia proposes to make use of

And, Whereas, claims may be hereafter made for the use of said by party or parties at present unknown to the District of Columbia, under and by virtue of Letters Patent granted by the United States:

Now, Therefore, the condition of the above obligation is such that if the said or other legal representatives shall hereafter indemnify and save harmless the said District of Columbia from the above-mentioned claims for royalty and from any and all claims of whatsoever kind arising in any manner out of the use of said or the machinery, or the use thereof, or material and devices in the manufacture of the which may be used on any of the streets, avenues, alleys, or public places in the District of Columbia by said which may be hereafter preferred against the District of Columbia, and from all suits, costs, charges, counsel fees, judgments, and damages which said District of Columbia may be subjected to by virtue of said claims, or any of them, and the said or other legal representatives shall pay the same,

then this obligation to be void, otherwise to remain in full force and virtue.

Signed and sealed in the presence of
..... [L. S.]
..... [L. S.]
..... [L. S.]
..... [L. S.]

Approved :

.....
.....
.....

Commissioners, D. C.

Justification and Sureties.

BONDSMEN'S OATH.

DISTRICT OF COLUMBIA, *County of Washington.* } *ss :*

I, being duly sworn, depose and say that I reside in the District of Columbia ; that I am a freeholder therein ; and that the value of my real estate, over and above all debts, liabilities, and exemptions, is over dollars ($); and that I am fully responsible for the amount of my obligation in the foregoing bond by me executed.

Sworn and Subscribed, this day of , 189 , before me.

....
Notary Public.

DISTRICT OF COLUMBIA, *County of Washington.* } *ss :*

I, , being duly sworn, depose and say that I reside in the District of Columbia ; that I am a freeholder therein ; and that the value of my real estate, over and above all debts, liabilities, and exemptions, is over dollars ($); and that I am fully responsible for the amount of my obligation in the foregoing bond by me executed.

Sworn and Subscribed, this day of 189 , before me.

.....
Notary Public.

PAY-ROLL NO.

Work on Appropriation for

We, the undersigned, acknowledge to have received from the District of Columbia the sums set opposite our respective names in full payment for services rendered from 189 , to 189 .

No.	Name.	Service.	Days.	Rate.	Total Received.	Paid by Check No.	Signature.	Witness.
1	.....	.....	.....	.....	.....	.....	.....	.....
2	.....	.....	.....	.....	.....	.....	.....	.....
etc.								

I certify that the foregoing amounts are correct, that no one whose name appears on this roll has been absent from sickness or any other cause during the time for which pay is claimed, but that the services were actually rendered in full, as stated, and that I have no interest in the pay of any employee on this roll.

.....
Superintendent of.....

Examined and approved : .....
Captain of Engineers, U. S. A.

[Back of Form.]

The "Days," reported on the reverse side hereof were derived from the daily time given below that each employee worked. For a whole day's work 1 is entered under date worked and for a fractional part of a day the proper fraction in eights only. Eight hours constitute one day.

The "No. on Pay-roll" corresponds to that on the reverse side hereof.

No on Pay-roll.	189 .																													Total.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	

OFFICE OF THE AUDITOR,

DISTRICT OF COLUMBIA.

Washington, 189 .

Audit No. Check No.

The within claim is hereby audited and approved for the sum of $\frac{}{100}$ dollars.

$

CHARGEABLE TO APPROPRIATION, 189 .

.....

.....

.....

Auditor, District of Columbia.

Certified by—

..... } Commissioners
..... } D. C.
..... }

Recorded Journal page

Personal Ledger No. page

[Voucher.]

No. Folio WASHINGTON, D. C. , 189 .

DISTRICT OF COLUMBIA,

For appropriation

To.....Dr.

Date.	No. Voucher.			

Received payment by warrant on the United States Treasury No.

.....

I certify that the accompanying bill is correct, and that the articles specified conform in kind and quality with the requirements of Contract No. under which they have been ordered.

189 .

.....

Property Clerk.

[Back of Form.]

WASHINGTON, D. C., , 189 .

.....

Invoice and vouchers for furnished the D. C., during the month of in accordance with Contract No.

$

Respectfully forwarded to the

....

By order :

.....

Property Clerk.

189 . No. Folio

AUDITOR'S OFFICE,

DISTRICT OF COLUMBIA.

WASHINGTON, D. C., 189 .

.....

Claim No. Check No.

The within claim is hereby audited and approved for the sum of $\frac{}{100}$ dollars

$

CHARGEABLE TO APPROPRIATION:

.....

.....

.....

Auditor, District of Columbia.

Certified by

..... } Commissioners, D. C.
..... }
..... }

Recorded Journal page
Personal Ledger No. page

Respectfully forwarded to the

AUDITOR, D. C.

Approved:

.....
.....

189 . No. Folio

MATERIAL VOUCHER No.

Material furnished on Appropriation for

We, the undersigned, acknowledge to have received from the District of Columbia the sums set opposite our respective names in full payment for material furnished, per verbal agreement, from 189 , to 189 .

No.	Name.	Quantity.	Rate.	Total Received.	Paid by Check No.	Signature.	Witness.
1							
2							
3							
4							

Correct: .....

Overseer.

I certify that the above account of material is correct, and that the prices charged are in accordance with verbal agreement and are not above market prices.

.....

Superintendent of .....

Examined and approved: .....

Captain of Engineers, U. S. A.

[Back of Voucher.]

OFFICE OF THE AUDITOR,
DISTRICT OF COLUMBIA,

WASHINGTON, 189 .

.....

Audit No. Check No.

The within claim is hereby audited and approved for the sum of $\frac{}{100}$ dollars.

$

Chargeable to appropriation 189 .

.....
.....
.....

Auditor, District of Columbia.

Certified by

..... } Commissioners, D. C.
..... }
..... }

Recorded Journal page
Personal Ledger No. page

WASHINGTON, D. C., 189 .

DISTRICT OF COLUMBIA,

To.....Dr.

For.....	.....
.....	.....
.....	.....

Received payment by check on United States Treasury No.

.....

.....

It is hereby certified, that the above bill is correct, and unpaid.

.....

PRESENT BILL IN DUPLICATE.

[Back of Voucher,]

OFFICE OF THE AUDITOR,

DISTRICT OF COLUMBIA,

WASHINGTON, 189 .

.....

Audit No. Check No.

The within claim is hereby audited and approved for the sum $\frac{}{100}$ dollars

$

Chargeable to appropriation 189 .

.....

.....

.....

Auditor, District of Columbia.

Certified by

..... }
..... } Commissioners, D. C.
..... }

Recorded Journal page

Personal Ledger No. page

(Statement of Indebtedness which, accompanied by one of the forms of measurement sheets, is sent to Auditor as a basis for payment on one of the forms of vouchers.)

No. Vol. 189 , E. D.

Measurement Contract No.

Chargeable to appropriation for.....

189

ENGINEER DEPARTMENT, DISTRICT OF COLUMBIA,

WASHINGTON, 189 .

District of Columbia

To.....Dr.

FOR WORK ON.	BETWEEN.	STREETS.

MATERIALS FURNISHED UPON THIS CONTRACT.

Chargeable against contractor.	Not chargeable against contractor.
....	.....
.....	.....
.....	.....

The above account of material is correct as appears by the reports and receipts filed in this office. The measurement sheet upon which this voucher is based is attached hereto, the prices herein charged are correct, and the voucher is approved and referred to the auditor of the District of Columbia for settlement.

.....

Chief Clerk.

Received payment by warrant upon the United States Treasury, No.

.....

.....

[Back of Form.]

Account No.

Dated 189 .

.....Contractor.

Measurement.

Contract No.

Chargeable to appropriation for

189 .

For work

(.....)

done on

.....

(between and sts.)

....

Cost of work, $

Cost of material, $

Total, $

OFFICE OF THE AUDITOR,
DISTRICT OF COLUMBIA,
WASHINGTON, 189 .

.....

Audit No. Check No.

The within claim is hereby audited and approved for the sum of $\frac{}{100}$ dollars.

$

Chargeable to appropriation 189 .

.....
.....
.....

Auditor, District of Columbia.

Certified by

..... } Commissioners,
..... } D. C.
.....

189 .

Recorded Journal page
Personal Ledger No. page

[Measurement Sheet.]

RECAPITULATION OF CONTRACT No.

Street between and

Contractor..... No. of contract . 189 .

	Surface Sheet.	Grading. Cubic Yards.	Rock Excavation. Cubic Yards.	Haul over 500 ft.	Old Curb Removed. Lineal Feet.	Old Cobble, etc., Removed. Square Yards.	12" Flagging. Lineal Feet.	16" Flagging. Lineal Feet.	Bluestone Curb. Lineal Feet.		Granite Curb. Lineal Feet.		Circular Curb. Lineal Feet.		Cobble. Square Yards.	Footwalk. Square Yards.	Carriageway Pavement. Square Yards.	
									Set.	Reset.	Set.	Reset.	Set.	Reset.				
	1																	
	2																	
	3																	
	Total.																	

STATEMENT OF ACCOUNT.

CONTRACT WORK.			EXTRA WORK.					

I hereby certify that I have examined, measured, and inspected this work; that the quantities here given are correct, and that it conforms to the specifications of the contract. No portion of the work here certified has been done upon a street under guarantee of repairs nor upon the space between railroad tracks and two feet exterior thereto.

189 . .....

Assistant Engineer.

Examined and approved: Approved 189 .

189 .

.....

..... *Captain of Engineers, U. S. A.,*

Computing Engineer. *Assistant to Engineer Commissioner, D. C.*

[Measurement Sheet.]

Measurement of Work done by.....under Contract No. during the month of 189 .

Section.	Location. Street.	From	To	Cubic Yards. Cutting out and removing old Concrete, Pavements, etc.	Cubic Yards. Base @ $	Cost. $	Cubic Yards. Binder @ $	Cost. $	Cubic Yards. Coal Tar @ $	Cost. $	Cubic Yards. Asphalt @ $	Cost. $	Total Cost. $	

Correct:

189

.....
Contractor.

I hereby certify that I have examined, measured, and inspected this work; that the quantities here given are correct, and that it conforms to the specifications of the contract. No portion of the work here certified has been done upon a street under guarantee of repairs nor upon the space between railroad tracks and two feet exterior thereto.

189 .

.....
Inspector.

Examined and Approved:

189

.....
Supt. of Streets.

Approved 189 .

.....
Captain of Engineers, U. S. A.;
Assist. to Eng. Commissioner, D. C.

[Measurement Sheet.]

MEASUREMENT UNDER CONTRACT No. FOR SEWER.

....., Contractor. , 189 .

Location. Street.	From—	To—	12-inch Pipe Sew. Laid. Lin. Feet	15-inch Pipe Sew. Laid. Lin. Feet.	18-inch Pipe Sew. Laid. Lin. Feet.	21-inch Pipe Sew. Laid. Lin. Feet.	24-inch Pipe Sew. Laid. Lin. Feet.	Laid. Lin. Feet.	Laid. Lin. Feet.	Laid. Lin. Feet.	Laid. Lin. Feet.	Excavation and Refilling. Cubic Yards. Excess.	Deficit.	Brick Masonry. Cubic Yards. Excess.	Deficit.	Concrete Masonry. Cubic Yards. Excess.	Deficit.	Lumber. Left in Trench. Feet B. M	Rock. Excavation. Cubic Yards.

STATEMENT OF ACCOUNT.

Contract Work.			No. of Order.	Extra Work.		

I hereby certify that I have examined, measured, and inspected this work, and that the quantities here given are correct. The work appears to be well done.

189 .

.....
Assistant Engineer.

I certify that I have repeatedly inspected this work during its progress and that it conforms to the specifications of the contract.

189 .

.....
General Inspector.

Examined and Approved.

189 .

.....
Superintendent of Sewers.

Approved 189

.....
Captain of Engineers, U. S. A.;
Assist. to Eng. Commissioner, D. C.

[Measurement Sheet.]

NO. OF CONTRACT .

Street between

Reference to Field Book,

189 .

Grading.		Flagging.		Curbing—Feet.			Sidewalk.		Carriageway.		Cobble.	
Cubic Yards.												
Ordinary Excavation.	Rock.	12″ Lin. Feet.	16″ Lin. Feet.	Bluestone.	Granite.	Circular.	Dimensions	Square Feet	Dimensions	Square Feet	Dimensions	Square Feet

Hor. Scale,

.....
Leveller.

.....
Computing Engineer.

BUILDING FOR LIBRARY OF CONGRESS—FORMS.*

PROPOSAL FOR.....

, 18 .

To Mr. BERNARD R. GREEN,
Superintendent and Engineer,
Building for the Library of Congress,
Washington, D. C.

SIR: In accordance with your advertisement of , 18 , inviting proposals for for the Building for the Library of Congress, in Washington, D. C., and subject to all the conditions and requirements thereof, and of the circular specifications and general instructions and conditions, of the same date, copies of all of which are hereto attached, and, so far as they relate to this proposal, are made a part of it, we [or] I propose to furnish and deliver all of said for the following price , to wit:

We [or] I make this proposal with a full knowledge of the kind, quantity, and quality of the articles, materials, and work required, and, if it is accepted within sixty (60) days from this date, will, within ten (10) days after receiving notice of such acceptance, enter into contract with the proper officer of the United States, with two good and sufficient sureties in the sum of dollars ($) each, for the faithful performance thereof.

[Signature] .....
[Address] .....
[Signature] .....
[Address] .....

* For the regulations and instructions relating to these forms see Chapter VII.

Contract, Bond, Justification of Sureties, and Certificate.

Articles of Agreement entered into this day of eighteen hundred and (18), between THOS. LINCOLN CASEY, Chief of Engineers, U. S. Army, of the first part, for and in behalf of the United States of America, and and partners, doing business under the firm-name of of of the county of , State of of the second part:

This agreement witnesseth, That, in conformity with the advertisement, general instructions and conditions, specifications, and proposal hereunto attached, all of which enter into and form a part of this contract in the same manner as if specifically set forth herein, the said THOS. LINCOLN CASEY, Chief of Engineers, U. S. Army, and the said

for heirs, executors, and administrators, have mutually agreed, and by these presents do mutually covenant and agree, to and with each other, as follows, to wit: That the said party of the second part shall furnish , called for in the said specifications, for the BUILDING FOR THE LIBRARY OF CONGRESS, in Washington, in the District of Columbia,

All materials furnished and work done under this contract shall, before being accepted, be subject to a rigid inspection by an inspector appointed on the part of the Government, and such as do not conform to the specifications set forth in this contract shall be rejected. The decision of the Chief of Engineers, U. S. Army, as to quality and quantity shall be final.

The said shall commence the called for by this contract, on or before the day of , eighteen hundred and (18), and shall complete the said on or before the day of , eighteen hundred and (18).

If, in any event, the party of the second part shall delay or fail to commence with the delivery of the material or the performance of the work on the day specified herein, or shall, in the judgment of the party of the first part, fail to prosecute, faithfully and diligently, the work in accordance with the specifications and requirements of this contract, then, in either case, the party of the first part, or his successor legally appointed, shall have power to annul this contract by giving notice in writing to that effect to the party of the second part; and, upon the giving of such notice, all money or reserved percentage due or to become due to the party of the second part, by reason of this contract, shall be and become forfeited to the United States; and the party of the first part shall be thereupon authorized, if an immediate performance of the work or delivery of the materials be, in his opinion, required by the public exigency, to proceed to provide for the same by open purchase or contract, as prescribed in Section 3709 of the Revised Statutes of the United States: *Provided, however*, That if the party of the second part shall by freshets, ice, or other force or violence of the elements, and by no fault of his or their own, be prevented either from commencing or completing the work, or delivering the materials at the time agreed upon in this contract, such additional time may, in writing, be allowed him or them for such commencement or completion as, in the judgment of the party of the first part, or his successor, shall be just and reasonable; but such allowance and extension shall in no manner affect the rights or obligations of the parties under this contract, but the same shall subsist, take effect, and be enforceable precisely as if the new date for such commencement or completion had been the date originally herein agreed upon.

If, at any time during the prosecution of the work, it be found advantageous or necessary to make any change or modification in the project, and this change or modification should involve such change in the specifications as to character and quantity, whether of labor or material, as would either increase or diminish the cost of the work, then such change or modification must be agreed upon in writing by the contracting parties, the agreement setting forth fully the reasons for such change, and giving clearly the quantities and prices of both material and labor thus substituted for those named in the original contract: *Provided*, That no payments shall be made unless such supplemental or modified agreement was signed before the obligation arising from such modification was incurred.

No claim whatever shall at any time be made upon the United States by the party of the second part for or on account of any extra work or material performed or furnished, or alleged to have been performed or furnished under or by virtue of this contract, and not expressly bargained for and specifically included herein, unless such extra work or materials shall have been expressly required in writing by the party of the first part, or his successor, the prices and quantities thereof having been first agreed upon by the contracting parties.

The party of the second part shall be responsible for and pay all liabilities incurred, in the prosecution of the work, for labor and material.

It is further understood and agreed that, in case of failure on the part of the party of the second part to complete this contract as specified and agreed upon, all sums due and percentage retained shall thereby be forfeited to the United States, and that the said United States shall also have the right to recover any or all damages due to such failure in excess of the sums so forfeited, and also to recover from the party of the second part, as part of said damages, whatever sums may be expended by the party of the first part in completing the said contract, in excess of the price herein stipulated to be paid to the party of the second part for completing the same.

The said party of the second part hereby warrants, that as to such of the articles or their application herein agreed to be by him or them supplied or furnished, as may be patented, said articles shall not infringe any patent of which the said party of the second part is not the patentee, or assignee, or lawfully entitled to sell the same for the uses aforesaid, and hereby covenants with the said party of the first part that will at

all times well and truly save, keep, and bear harmless, and fully indemnify the United States, and any of its officers or agents, from and for all damages or claims for damages, costs, or expenses, in law or equity, that may at any time arise or be set up for any infringement of the patent-right of any person or persons in consequence of the use by the Chief of Engineers, U. S. Army, or by any of his agents, of the article or articles, or the application thereof contracted for under this contract.

The said party of the second part further stipulates and agrees that if at any time during the continuance of this contract either or both of the sureties hereto shall die, or become irresponsible, the party of the first part shall have the right to require additional and sufficient sureties, which the said party of the second part shall thereupon furnish to the acceptance of the Chief of Engineers, U. S. Army, within ten days after notice so to do; and in default thereof this contract may be annulled at the option of the Chief of Engineers, U. S. Army.

Payments shall be made to the said when the contracted for shall have been delivered and accepted, reserving ten per cent from each payment until the whole of the shall have been so delivered and accepted.

Neither this contract nor any interest therein shall be transferred by the said to any other party; and any such transfer shall cause the annulment of the contract so far as the United States is concerned. All rights of action, however, to recover for any breach of this contract by the said are reserved to the United States.

No member of or delegate to Congress, nor any person belonging to, or employed in, the military service of the United States, is or shall be admitted to any share or part of this contract, or to any benefit which may arise herefrom.

In witness whereof, the undersigned have hereunto placed their hands and seals the date first hereinbefore written.

WITNESSES:

..... } ..... [SEAL.]
Chief of Engineers, U. S. Army.
..... } ..... [SEAL.]

(Executed in triplicate.)

CONTRACTOR'S BOND.

Know all men by these presents, That we, , of , as principal, and , of , and , of , as sureties, are held and bound unto the UNITED STATES OF AMERICA in the penal sum of dollars ($), to the payment of which sum, well and truly to be made, we do bind ourselves and each of us, our and each of our heirs, executors, administrators, and assigns, for and in the whole jointly and severally, firmly by these presents.

Given under our hands and seals this day of , 189 .

THE CONDITION OF THIS OBLIGATION is such, that whereas the above-bounden ha , on the day of , 189 , entered into a contract with THOS. LINCOLN CASEY, Chief of Engineers, U. S. Army, for furnishing for the BUILDING FOR THE LIBRARY OF CONGRESS, in Washington, D. C.:

Now, therefore, if the above-bounden , heirs, executors, and administrators, shall and will, in all respects, duly and fully observe and perform all and singular the covenants, conditions, and agreements, in and by the said contract agreed and covenanted by to be observed and performed, and according to the true intent and meaning of the said contract, and as well during any period of extension of said contract that may be granted on the part of the United States as during the original term of the same, then the above obligation shall be void and of no effect; otherwise to remain in full force and virtue.

WITNESSES:

.... [L. S.]
.... [L. S.]
.... [L. S.]

(Executed in triplicate.)

NOTE.—Neither firms nor bonded officers of the United States will be accepted as sureties, nor will a partner be accepted as surety for a co-partner or for a firm of which he is a member, nor an officer of a corporation as surety for such corporation.

STATE OF
County of } *ss:*

I, , one of the sureties named in the within bond, do swear that I am pecuniarily worth the sum of dollars, over and above all my debts and liabilities.

[Signature of surety.] .....

Before me,

[Signature or officer administering oath, with seal, if any.] } .....

.....

STATE OF
County of } *ss:*

I, , one of the sureties named in the within bond, do swear that I am pecuniarily worth the sum of dollars, over and above all my debts and liabilities.

[Signature of surety.] .....

Before me,

[Signature of officer administering oath, with seal, if any.] .....

.....

I, , do hereby certify that and , the sureties above named, are personally known to me, and that, to the best of my knowledge and belief, each is pecuniarily worth, over and above all his debts and liabilities, the sum stated in the accompanying affidavit subscribed by him.

[Signature of certifying official.] ....

NOTE.—The certifying official must be a United States Judge, U. S. District Attorney, Clerk of United States Court, Collector of Customs or other United States officer. The certificate may be given separately as to each surety, and modified accordingly.

VOUCHER.

THE UNITED STATES,

To , Dr.

ON ACCOUNT OF THE APPROPRIATION FOR "BUILDING FOR LIBRARY OF CONGRESS—CONSTRUCTION."

DATE. 189	DESIGNATION.	APPLICATION.	AMOUNT.	
			Dollars.	Cents.

I certify that the above articles have been received in good order, and in the quantities above stated.

.....

Receiver of Material.

I certify that the articles above enumerated have been received, or services rendered; that they were necesary for and have been, or will be, applied to the construction of the "Building for Library of Congress," and that the prices paid were, in my opinion, just and reasonable, and that the purchases were made in open market or under contract, in compliance with Section 3709 Revised Statutes.

Approved:

....

Chief of Engineers, U. S. A. *Superintendent and Engineer.*

RECEIVED, at Washington, D. C., this day of 189 , from Gen. THOS. LINCOLN CASEY, Chief of Engineers, U. S. Army, the sum of $\frac{}{100}$ dollars, in full payment of the above account.

$ (Signed in duplicate.) .....

Paid by check on UNITED STATES TREASURER, No. dated , 189 .

CHAPTER IX.

DIRECTORY OF PUBLIC WORKS.

WORKS UNDER WAR DEPARTMENT AND OFFICERS IN CHARGE.

SECRETARY OF WAR:
HON. DANIEL S. LAMONT,
War Department, Washington, D. C.

ASSISTANT SECRETARY OF WAR:
HON. JOSEPH B. DOE,
War Department, Washington, D. C.

FORTIFICATIONS AND RIVER AND HARBOR WORKS.

(*Grouped by districts in geographical order.*)

To find a work, look for the city in this list nearest the location of the work. Then look in the list of works under the charge of the engineer office in that city.

The officers charged with these works are subject to change at any time. Changes in the arrangement of the districts and in the location of the headquarters offices are infrequent. Letters to the officer in charge of any district can be addressed: "The Engineer Officer in charge of District, United States Engineer Office," etc. etc. The following list is correct for April 1, 1895.

HEADQUARTERS CORPS OF ENGINEERS, WAR DEPARTMENT, WASHINGTON, D. C.

* Brigadier-General, THOS. LINCOLN CASEY, Chief of Engineers.

In command of the Corps of Engineers, and in charge of the Engineer Department. Charged with the supervision of such matters connected with construction of jetties and other works at South Pass, Mississippi River, as require the action of the Secretary of War. Member of Rock Creek Park Commission, and of Board of Control of Rock Creek Park, by virtue of act of Congress approved September 27, 1890. Member of Commission on suburban highways, District of Columbia, by virtue of act of Congress approved March 2, 1893.

Major HENRY M. ADAMS, Corps of Engineers. First Assistant in office of Chief of Engineers.

Captain GEORGE W. GOETHALS, Corps of Engineers. Disbursing Officer, office of Chief of Engineers.

DISTRICT OFFICES.

Portland, Maine.—United States Engineer Office, No. 537 Congress Street. Major DAVID PORTER HEAP, Corps of Engineers, in charge.

Works.—Defensive works at Forts Knox, Popham, Gorges, Scammel, Preble, and McClary; batteries at Portland Head and Gerrish's Island, Me., and at Fort Constitution and Jerry's Point, N. H.

Improvement of Harbors at Belfast, Camden, and Rockland, and Back Cove, Portland Harbor, Me.; harbor of refuge at Little Harbor, N. H., and the construction of breakwater from Mount Desert to Porcupine Island, Me. Improvement of rivers: Penobscot, Saco, including breakwater, Narragaugus, Bagaduce, Kennebec, Harraseeket, and St. Croix, Me.; Cocheco and Bellamy, N. H.; Lubec Channel and Moosabec Bar, Me.

Boston, Mass.—United States Engineer Office, Room 124, Post-office Building. Lieutenant-Colonel SAMUEL M. MANSFIELD, Corps of Engineers, in charge.

Works.—Defensive works at Forts Warren, Winthrop, Standish, Andrew, Independence, and on Long Island Head, Mass. Construction of gun and mortar batteries for defense of Boston harbor. Improvement of the harbors at Newburyport, Lynn, Boston (including sea-walls on Point Allerton, Great Brewster Island, Lovells Island, Gallops Island, Long Island Head, Rainsford Island, and Deer Island; Mystic and Charles rivers; Fort Point Channel; channel leading to Nantasket Beach and Main Ship Channel), Provincetown, Plymouth, Scituate, Hingham, Gloucester, Winthrop, Wellfleet, Manchester, Kingston, Salem, includ-

* Date of retirement from active service in U. S. Army, May 10, 1895.

ing South River, and Stage Harbor at Chatham, Mass. Construction of a harbor of refuge at Sandy Bay, Cape Ann, Mass. Improvement of the Merrimac, Ipswich, Powow, Weymouth, including Weymouth Back River, Mystic, Malden, and Essex rivers, Mass. Survey of Great Salt Pond, Block Island, R. I. To supervise the rebuilding of Market Street and Arsenal Street bridges; the alterations in bridges across Charles River; the construction of bridge across Fort Point Channel at Dover Street, and over Chelsea Creek at Chelsea Street; and the construction of a temporary bridge across Mystic River, at Boston, Mass.

Newport, R. I.—United States Engineer Office, No. 192 Thames Street. Captain WILLIAM H. BIXBY, Corps of Engineers, in charge.

Works.—Defensive works of forts at Clark's Point, Mass.; Dutch Island, and Fort Adams, R. I. Improvement of the harbors of Wareham, Hyannis, New Bedford, Vineyard Haven, Martha's Vineyard, inner harbor, Mass.; Newport, Block Island, and entrance to Point Judith Pond, R. I.; and Stonington, Conn.; harbor of refuge at Nantucket, and Canapitsit Channel, Mass.; and construction of harbor of refuge at Point Judith, R. I. Improvement of the rivers Taunton, Mass.; Pawcatuck, R. I. and Conn.; Pawtucket, Providence River, Narragansett Bay, and Green Jacket Shoal, Providence River, R. I. Survey of Stonington Harbor, Conn.; Tarpaulin Cove, Naushon Island, Woods Holl and Little Woods Holl Harbor, Mass.; Wickford Harbor, R. I., and Pawcatuck River, R. I. and Conn. Examination of Onset and Hyannis harbors, Bass River, Mass.; Connanicut Island, for cutting a channel through the same, and Seaconnet Point, R. I. To supervise the construction of bridge across Seekonk River, R. I., and across Cohasset Narrows, Mass.

New York, N. Y.—United States Engineer Office, Army Building, Whitehall Street. Colonel HENRY M. ROBERT, Corps of Engineers, in charge.

Works.—Defensive works at Forts Griswold and Trumbull, Conn.; Columbus, Wood, Wadsworth, and Tompkins and its batteries, Castle William, South Battery at Governor's Island, and of sea-wall at same, N. Y. Construction of gun-batteries on Staten Island, for defense of New York. Improvement of the harbors of New Haven, Bridgeport, Black Rock, Five Mile River, Stamford, Norwalk, Cos Cob and Miamus River; Conn.; and Port Chester, Glen Cove, Flushing Bay, Port Jefferson Inlet, Larchmont, and Huntington, N. Y.; of the harbor of refuge, Duck Island Harbor; and the construction of breakwaters at New Haven, Conn. Improvement of the Housatonic River and breakwater; Thames River, including Shaw's Cove, New London Harbor; Mystic and Saugatuck rivers, Conn.; Connecticut River, Mass. and Conn.; and East Chester Creek, Patchogue River, and Browns Creek, N. Y. Survey of Westport and Norwalk harbors, Conn. To supervise the rebuilding of bridge across Connecticut River between Hartford and East Hartford, Conn.

Willets Point, N. Y. Harbor.—United States Engineer Office. Lieutenant-Colonel WILLIAM R. KING, Corps of Engineers, in charge.

Works.—Defensive works at Fort Schuyler and Willets Point; the Engineer Depot at Willets Point; torpedoes for harbor defense, and experiments with the same. Construction of gun and mortar batteries for defense of New York at eastern entrance of harbor, and of sea-wall at Davids Island, N. Y.

New York, N. Y.—United States Engineer Office, Army Building, Whitehall Street. Lieutenant-Colonel GEORGE L. GILLESPIE, Corps of Engineers, in charge.

Works.—Defensive works at Forts Hamilton and Lafayette, N. Y., and Fort at Sandy Hook, N. J. Construction of gun and mortar batteries for defense of New York, and sea-wall on the north shore of Sandy Hook, N. J. Improvement of the harbors of New York, Rondout, Saugerties, and Canarsie Bay, N. Y.; Raritan Bay and Keyport Harbor, N. J. Improvement of the Hudson and Harlem rivers, Bay Ridge, Red Hook, and Gowanus Bay channels, Buttermilk Channel, and Jamaica Bay; deepening Gedney's Channel, Newtown Creek and Bay, Wappinger's Creek, Sheepshead Bay and Sumpawanus Inlet, N. Y.; channel between Staten Island and New Jersey, Arthur Kill between Staten Island and the New Jersey shore, N. Y. and N. J.; of the rivers Shrewsbury, Rahway, Elizabeth, South, Raritan, and Passaic, mouth of Squan River, Shoal Harbor and Compton Creek, and Mattawan Creek, N. J.; and the removal of obstructions in East River and Hell Gate, N. Y. To supervise the construction of proposed bridge across the East River between the city of New York and Long Island, and of two bridges between the cities of New York and Brooklyn; of bridges across Harlem River at First Avenue, at Third Avenue, at Fourth Avenue, and at One Hundred and Fifty-fifth Street, New York City; across Hudson River in and between the city of New York and the State of New Jersey; and across Bronx River below West Farms, N. Y.; of temporary bridges across Harlem River at Third Avenue, at Fourth Avenue, and at One Hundred and Fifty-sixth Street, New York City; the reconstruction of bridge across Spuyten Duyvil Creek, N. Y.; of certain work of the Hudson Tunnel Railway Company; of two piers on the Jersey Flats, New York Bay, at Bayonne, N. J.; and the use of the United States dike on Newark Bay front, N. J.

Philadelphia, Pa.—United States Engineer Office, No. 1428 Arch Street. Major CHARLES W. RAYMOND, Corps of Engineers, in charge.

Works.—Defensive works at Fort Mifflin, Pa.; Fort Delaware, and fort opposite Fort Delaware, Del.; at Finns Point, and site for defenses at Red Bank, N. J. Improvement of the harbors at Philadelphia, Pa., and N. J., and Delaware Breakwater, Del.; ice harbors at Marcus Hook, Pa., and the head of Delaware Bay, Del.; of the Schuylkill River, Pa.; Delaware River, from Trenton to its mouth;

Rancocas and Salem rivers; Alloway and Goshen creeks, N. J., and Frankford Creek, Pa. To supervise the construction of bridge across Delaware River, Frankford (2) and Pennypack creeks, at Philadelphia, Pa.

Wilmington, Del.—United States Engineer Office, No. 824 Adams Street. Major WM. F. SMITH, U. S. A., retired, U. S. Agent, in charge.

Works.—Improvement of the harbor at Wilmington, and Christiana River, Del.; of the harbors at Cambridge, Md., Onancock, and Cape Charles City and Chenton Inlet, Va.; and ice harbor at New Castle, Del. Improvement of the Broadkiln, Appoquinimink, Smyrna, Murderkill, Mispillion, and Broad Creek rivers, Del.; Susquehanna River, Md. and Pa.; Choptank, Wicomico, Manokin, Chester, Latrappe, Warwick, and Elk rivers, and of Fairlee Creek or Inlet, Md.; and inland waterway from Chincoteague Bay, Va., to Delaware Bay at or near Lewes, Del. Survey of Nanticoke River, Del., and of Pocomoke River, Md.

Baltimore, Md.—United States Engineer Office, No. 9 Pleasant Street. Colonel WILLIAM P. CRAIGHILL, Corps of Engineers, in charge.

Works.—Defensive works at Forts Carroll and McHenry, Baltimore, Md. Improvement of the harbor at Baltimore, Md.; of Patapsco River and channel to Baltimore, Md.; James River, Va.; and Gauley, Great Kanawha, and Elk rivers, W. Va.; and protecting Jamestown Island from the encroachments of James River, Va. To supervise the construction of bridge across Elk River at Clendennin, W. Va.

Washington, D. C.—United States Engineer Office, No. 601 Eighteenth Street, N. W. Major CHARLES E. L. B. DAVIS, Corps of Engineers, in charge.

Works.—Defensive works at Forts Foote and Washington, Md.; Wool and Monroe, Va. Improvement of the Potomac River in the vicinity of Washington; of channel in the Eastern Branch Potomac River; of Patuxent River, Md.; of the rivers Rappahannock, Mattaponi, York, and Pamunkey, and of Nomini, Urbanna, Occoquan, Aquia, and Lower Machodoc creeks, Va. Construction of the sewerage system at Fort Monroe, Va. Repairs to the Aqueduct Bridge, D. C. To supervise the reconstruction of the Washington shore end of the Long Bridge at Washington, D. C.; the construction of bridge across Potomac River at The Three Sisters, D. C.; and across Patuxent River at Mount Calvert, Md.

Norfolk, Va.—United States Engineer Office, No. 106 Granby Street. Captain THOMAS L. CASEY, Corps of Engineers, in charge.

Works.—Improvement of the harbor at Norfolk, and the approach to Norfolk Harbor and the U. S. Navy-yard, Va. Improvement of the Appomattox, Chickahominy, and Nansemond rivers, including mouths of Bennett and Chuckatuck creeks, Va., North Landing River, and inland water route from Norfolk Harbor, Va., to Albemarle Sound, N. C., Roanoke and Pasquotank rivers, and Mackey's Creek, N. C. Survey of the waterways through the sounds of North Carolina and of the Dismal Swamp Canal, Va. and N. C. To supervise the construction of bridge across Scott's Creek, Va.

Wilmington, N. C.—United States Engineer Office, Post-Office Building. Major WILLIAM S. STANTON, Corps of Engineers, in charge.

Works.—Defensive works at Forts Macon and Caswell, and the Fort Johnston military reservation, N. C. Improvement of the harbors at Beaufort, N. C.; Georgetown and Winyaw Bay, S. C. Improvement of Cape Fear River above and below Wilmington; Neuse, Pamlico, Tar, Black, Trent, New, North East (Cape Fear), and Lockwood's Folly rivers, Contentnia and Fishing creeks, Ocracoke Inlet, and inland waterway from New Berne to Beaufort, inland waterway between Beaufort Harbor and New River, and waterway between New River and Swansboro, N. C. Survey of Cape Fear River, N. C. To supervise the construction of bridge across Contentnia Creek, at or near Grifton, and across Neuse River, N. C.

Charleston, S. C.—United States Engineer Office, No. 12 Southern Wharf. Captain F. V. ABBOT, Corps of Engineers, in charge.

Works.—Defensive works at Forts Moultrie, Sumter, and Johnson, and Castle Pinckney, S. C. Improvement of the harbor at Charleston, S. C. Improvement of Lumber River, and of Waccamaw River, N. C. and S. C.; of the Edisto, Salkiehatchie, Little Peedee, Great Peedee, Santee, Wateree, Congaree, Clark, and Beaufort rivers, Mingo Creek and Wappoo Cut, S. C. To supervise the construction of bridge across Lumber River, N. C., and across the cove at Sullivans Island, S. C.

Savannah, Ga.—United States Engineer Office, Southern Bank Building. Captain OBERLIN M. CARTER, Corps of Engineers, in charge.

Works.—Defensive works at Forts Oglethorpe and Pulaski, Ga., and Clinch, Fla. Improvement of the harbors at Savannah, Brunswick, and Darien, Ga. Improvement of Cumberland Sound, Savannah, Altamaha, Ocmulgee, and Oconee rivers, and Jekyl Creek, Ga., and inside route between Savannah, Ga., and Fernandina, Fla. To exercise supervision over the construction of bridges across the Oconee and St. Mary's rivers, Ga.

St. Augustine, Fla.—United States Engineer Office, Custom-House. Major THOMAS H. HANDBURY, Corps of Engineers, in charge.

Works.—Defensive works at Forts Marion and Taylor, Fla. Improvement of the harbors at Key West, including entrance thereto, Tampa Bay, Cedar Keys, and St. Augustine, Fla. Improvement of the St. John's River, Volusia Bar, Caloosahatchee River and Punta Rassa, Manatee, Withlacoochee, Suwanee, and Pease rivers, channel of Charlotte Harbor and Pease Creek Ocklawaha River, Indian River, and Sarasota Bay, Fla. Examination of St. John's River. To supervise the construction of bridges across St. John's, St. Lucia, Hillsborough, and Withlacoochee rivers, Fla.

Montgomery, Ala.—United States Engineer Office, Moses Building. Major F. A. MAHAN, Corps of Engineers, in charge.

Works.—Defensive works at Forts Pickens and Barrancas, Fla. Improvement of the harbors at Apalachicola Bay and River, and at Pensacola, Fla. Improvement of the rivers Coosa and Chattahoochee, Ga. and Ala., Flint, Ga.; Choctawhatchee, Escambia, and Conecuh, Fla. and Ala.; Apalachicola River, including Lee's Slough and its connection with the Chipola River, and from said connection to the mouth of Chipola River, Fla.; and Alabama, Ala. To supervise the construction of bridge across Alabama River near Montgomery, Ala.; and across Perdido River, Fla. and Ala.

Mobile, Ala.—United States Engineer Office, No. 150 St. Francis Street. Major ANDREW N. DAMRELL, Corps of Engineers, in charge.

Works.—Defensive works at Forts Morgan and Gaines, Ala., and Fort on Ship Island, Miss. Improvement of the harbor at Mobile, Ala. Improvement of the rivers Warrior and Black Warrior, Tombigbee and Warrior, Ala.; Tombigbee, Ala. and Miss.; Pascagoula, Pearl, Chickasahay, and Leaf, Miss.; and Bogue Chitto, La. To supervise the construction of the bridges between Mobile Bay and Mississippi Sound, from Cedar Point to Dauphin Island; across Three-Mile Creek; across Dog and Fowl rivers, Ala.; and across Fort Bayou at Ocean Springs, Miss.

New Orleans, La.—United States Engineer Office, No. 349 Carondelet Street. Major JAMES B. QUINN, Corps of Engineers, in charge.

Works.—Defensive works at Forts Jackson, St. Philip, Livingston, Pike, and Macomb, Tower Dupré, Battery Bienvenue, and Tower at Proctorsville, La. Improvement of the Amite River and Bayou Manchac, Tickfaw, Chefuncte River and Bogue Falia, Mermentau River and tributaries, mouth and passes of Calcasieu River, bayous Terrebonne, Courtableau, Teche, Lafourche, and Plaquemine, including removing obstructions from Grand River and Pigeon bayous; channel, bay, and passes of Bayou Vermilion, La.; harbor at Sabine Pass and Neches River, Tex.; and Sabine River, La. and Tex. To report upon the depth and width of a channel secured and maintained by jetties at the mouth of the Mississippi River. To supervise the construction of two bridges across Bayou La Fourche, and of bridge across Bayou Teche, near Loreauville, La.

New Orleans, La.—United States Engineer Office, No. 1 Prytania Street. Captain GEORGE McC. DERBY, Corps of Engineers, in charge.

Works.—4th District of the Mississippi River, from Warrenton to Head of the Passes, for the purpose of improvement and the construction and repair of levees, to include levees and special work on the river, the improvement of the harbor at New Orleans, the Mississippi River at Natchez and Vidalia, the mouth of Red River, and the rectification of the Red and Atchafalaya rivers at mouth of Red River. To supervise the construction of bridge across Mississippi River above New Orleans, La.

Galveston, Texas.—United States Engineer Office, Alvey Building, Major ALEXANDER M. MILLER, Corps of Engineers, in charge.

Works.—Improvement of the entrance to Galveston Harbor and of the harbor at Brazos Santiago, Tex. Improvement of ship channel in Galveston Bay, the channel in West Galveston Bay, Buffalo Bayou, Trinity River, and Cedar Bayou, Tex. Survey for determining the causes of the erosion of the easterly end of Galveston Island, Tex. To exercise supervision over the construction of bridge across Buffalo Bayou and Brazos River, Tex.

Vicksburg, Miss.—United States Engineer Office, No. 108 West Crawford Street. Captain JOSEPH H. WILLARD, Corps of Engineers, in charge.

Works.—Improvement of the harbor at Vicksburg, Miss.; Tensas River and Bayou Macon, La. and Ark.; Ouachita and Black rivers; Bayou Bartholomew in La. and Ark.; Boef River and bayous D'Arbonne and Corney, La., including removing obstructions from the Little D'Arbonne; Cypress Bayou, La. and Tex.; Red River, La. and Ark., including Sulphur River, and the Big Hatchee River, Tenn.; of the rivers Big Sunflower, Yazoo, Big Black, and Tallahatchee, Tchula Lake, Steeles and Washingtons bayous, and mouth of Yazoo River, Miss. Survey of Red River from Fulton, Ark., to the Atchafalaya River, La. Examination of Little River, La.; Bogue Phalia, Bear Creek, and Big Sunflower River, Miss. To supervise the construction of the bridge across Big Black River at Hankinsons Ferry, Miss., and across Sulphur River, Ark.

Little Rock, Ark.—United States Engineer Office, No. 823 Centre Street. Lieutenant WILLIAM L. SIBERT, Corps of Engineers, in charge.

Works.—Improvement of the Arkansas River, including removing obstructions and operating snag-boats, Ark. and Ind. Ter.; and of rivers White, St. Francis, Petit Jean, and Cache, Ark.; Black and Current, Ark. and Mo.; and St.

François, Mo.; and removal of rock shoals in Fourche River, Ark. Examination of Cache and Upper White rivers, Ark., and St. Francis River, Mo. To supervise the construction of bridges across the Arkansas River at Little Rock and at Cummings Landing; and across the Poteau River in the Choctaw Nation, near Fort Smith, Ark.

Memphis, Tenn.—United States Engineer Office, No. 106 Madison Street. Captain CURTIS MCD. TOWNSEND, Corps of Engineers, in charge.

Works.—3d District of the Mississippi River, from mouth of White River to Warrenton, for the purpose of improvement and the construction and repair of levees, to include the improvement of the harbor at Vicksburg, Miss.

Memphis, Tenn.—United States Engineer Office, No. 99 Madison Street. Captain GRAHAM D. FITCH, Corps of Engineers, in charge.

Works.—1st District of the Mississippi River from Cairo to foot of Island No. 40, and of 2d District from foot of Island No. 40 to mouth of White River, for the purpose of improvement and the construction and repair of levees. Examination of Wolf River, Tenn.

St. Louis, Mo.—United States Engineer Office, Custom-House. Major CHARLES J. ALLEN, Corps of Engineers, in charge.

Works.—Improvement of the Mississippi River—removal of snags, etc.; Mississippi River from the mouth of the Ohio River to the mouth of the Missouri River, and harbor at St. Louis, Mo., and Kaskaskia River, Ill. To exercise supervision over the construction of bridges across the Mississippi River at St. Louis, Mo., and at Alton, Ill.

St. Louis, Mo.—United States Engineer Office, 1515 Locust Street. Lieutenant-Colonel CHARLES R. SUTER, Corps of Engineers, in charge.

Works.—To exercise supervision over the construction of bridges across the Missouri River at or near Sioux City, Iowa; at Omaha, Neb.; near Council Bluffs, Iowa, and East Omaha, Neb.; between Kansas City and Sibley, Mo.; between Leavenworth, Kans., and Platte County, Mo.; at St. Charles, and between St. Charles and the mouth of Missouri River, Mo.

St. Louis, Mo.—United States Engineer Office, No. 1515 Locust Street. Lieutenant JAMES C. SANFORD, Corps of Engineers, in charge.

Works.—Secretary and Disbursing Officer of the Missouri River Commission. Improvement of Osage River, Mo. and Kans., and Gasconnade River, Mo.

St. Louis, Mo.—United States Engineer Office, No. 2732 Pine Street. Captain GEORGE A. ZINN, Corps of Engineers, in charge.

Works.—Secretary and Disbursing Officer of the Mississippi River Commission. Secretary and Assistant to the Construction Committee of the Mississippi River Commission and Disbursing Officer for works carried on by the Commission.

Rock Island, Ill.—U. S. Engineer Office. Lieutenant-Colonel ALEXANDER MACKENZIE, Corps of Engineers, in charge.

Works.—Improvement of the Mississippi River from the mouth of the Missouri to Minneapolis, from St. Paul to Minneapolis, and at Rock Island and Des Moines Rapids; and of Quincy Bay; and the care and maintenance of Galena River improvement, Illinois. Operating the dry-dock at the Des Moines Rapids Canal; the Des Moines Rapids Canal and snag boats and dredge-boats on Upper Mississippi River. To supervise the construction of bridges across the Mississippi River between Davenport, Iowa, and Rock Island, Ill.; at Muscatine, at Lyons, at or near Clinton, Iowa; at La Crosse, Wis.; at Hastings, at St. Paul, at or near South St. Paul, and at Red Wing, Minn.

St. Paul, Minn.—U. S. Engineer Office, Room 37, Globe Building. Major WILLIAM A. JONES, Corps of Engineers, in charge.

Works.—Improvement of the Chippewa River, including Yellow Banks; of the Minnesota and St. Croix rivers, the Red River of the North, and of the Mississippi River above the Falls of St. Anthony. Care and maintenance of Reservoirs at headwaters of the Mississippi River, including construction of a navigable pass through the Sandy Lake Dam. Gauging the waters of the Mississippi River and its tributaries at or near St. Paul, Minn. Examination of Red Lake River, Minn. To exercise supervision over construction of bridges across Red River of the North at Alpha, De Mers, and Minnesota avenues, Grand Forks, N. Dak.

Sioux City, Iowa.—United States Engineer Office, Fourth and Jackson Sts. Captain HARRY F HODGES, Corps of Engineers, in charge.

Works.—Improvement of the Upper Missouri River between Stubbs' Ferry, Mont., and the lower limits of Sioux City, Iowa, including removing snags and other like obstructions above Sioux City, and of the Yellowstone River, Mont. and N. Dak. Survey of Missouri River between Sioux City, Iowa, and Fort Benton, Mont. To supervise the construction of bridge across Missouri River at Yankton, S. Dak.

Nashville, Tenn.—United States Engineer Office, No. 802 Broad St. Captain JOHN BIDDLE, Corps of Engineers, in charge.

Works.—Improvement of the rivers Cumberland above and below Nashville, Ky. and Tenn., Caney Fork, Obion, and Forked Deer, including North Fork, Tenn.

Chattanooga, Tenn.—United States Engineer Office, Loveman Building. Captain THEODORE A. BINGHAM, Corps of Engineers, in charge.

Works.—Improvement of the Tennessee River above and below Chattanooga, Hiawassee, French Broad, Little Pigeon, and Clinch rivers, Tenn.

Cincinnati, Ohio.—United States Engineer Office, Custom-House. Lieutenant-Colonel AMOS STICKNEY, Corps of Engineers, in charge.

Works.—Improvement of the Ohio River and of the Muskingum River, Ohio; the construction of harbor of refuge at mouth of Muskingum River, and of a movable dam at or below the mouth of Beaver River, Pa.; and of operating snag-boats on the Ohio River. Survey of the harbor of Elizabethtown, Ill., and of Ohio River, movable dams, numbered three, four, and five, Penna. To exercise supervision over the construction of bridges across Ohio River near Ceredo, W. Va.; between Covington, Ky., and Cincinnati, Ohio, and at East Liverpool, Ohio, and the rebuilding of bridge across Ohio River from Cincinnati, Ohio, to Newport, Ky.

Pittsburg, Pa.—United States Engineer Office, P. O. Box 1240. Major RICHARD L. HOXIE, Corps of Engineers, in charge.

Works.—Improvement of Allegheny River, Pa., and of Cheat and Monongahela rivers, W. Va. and Pa.; the construction of a dam at Herrs Island, Allegheny River; and operating and care of locks and dams on Monongahela River. Survey of Allegheny River, Pa. Examination of Clarion River, Pa. To supervise the construction of bridges across Allegheny River at New Kensington, at Creighton; and below Tarentum; across Monongahela River at Pittsburg (four), near Pittsburg, and between Pittsburg and Homestead (two); and across Youghiogheny River in Fayette County, Pa.

Louisville, Ky.—United States Engineer Office, Room 6, Custom-House. Captain JAMES G. WARREN, Corps of Engineers, in charge.

Works.—Charge of the Louisville and Portland Canal. Improvement of the Falls of the Ohio River; the Indiana Chute, Falls of the Ohio River, Ky.; Wabash River, Ind. and Ill.; and White River, Ind. To exercise supervision over the construction of bridges across the Ohio River at Louisville, across Salt River near West Point, Ky., and across Little Wabash River at New Haven, Ill.

Cincinnati, Ohio.—United States Engineer Office, Custom-House. Major DANIEL W. LOCKWOOD, Corps of Engineers, in charge.

Works.—Improvement of Little Kanawha and Guyandotte rivers, W. Va.; Tug Fork of Big Sandy River, Big Sandy River, near Louisa, for movable dam, Kentucky; Tradewater, Green, and Barren rivers; Levisa Fork of Big Sandy River, Rough River, and of Licking River from Farmers to West Liberty, Ky. To exercise supervision over the rebuilding of bridge across Big Sandy River; and across the Kentucky River at Frankfort, Ky.

Duluth, Minn.—United States Engineer Office, Chamber of Commerce Building. Major CLINTON B. SEARS, Corps of Engineers, in charge.

Works.—Improvement of the harbors of Duluth, Grand Marais, Agate Bay, Minn.; Superior Bay and St. Louis Bay, and Ashland, Wis.; Ontonagon, Eagle Harbor, and Marquette; harbor of refuge at Grand Marais, and of the improvement, operating and care of waterway across Keweenaw Point, Lake Superior, Mich. Charge of water-level observations on Lake Superior. Examination and survey for the location of a canal connecting Lake Superior and the Mississippi River. Examination of harbors of Superior, Wis., and Duluth, Minn.

Milwaukee, Wis.—United States Engineer Office, No. 366 Milwaukee Street. Captain CARL F. PALFREY, Corps of Engineers, in charge.

Works.—Improvement of the harbors at Manistique and Cedar River, Mich.; Menominee, Mich. and Wis.; Oconto, Pensaukee, Ahnapee, Kewaunee, Two Rivers, Manitowoc, Sheboygan, Port Washington, Milwaukee, Racine, Kenosha, and Green Bay, including the Fox River below De Pere, Wis., and Waukegan, Ill.; and of harbors of refuge at Milwaukee Bay, and at Sturgeon Bay Canal, Wis. Charge of the Sturgeon Bay and Lake Michigan Ship Canal. Improvement of Menominee River, Wis. and Mich.; Fox River, including the harbor of Fond du Lac and approaches thereto; and removing sand-bar at outlet of Fond du Lac River, Wis. Charge of water-level observations on Lake Michigan. To supervise the construction of bridges across the Sheboygan River at Sheboygan; across Kewaunee River at Kewaunee; across North Menominee Canal; across Wolf River at Gills Landing; across Fox River and the Government Canal at Kaukauna; across the Fox River below Governors Bend Lock, and between Green Bay and Fort Howard; across Wisconsin River near Lone Rock; and the rebuilding of bridge across Fox River and the U. S. Canal at De Pere, Wis.

Chicago, Ill.—United States Engineer Office, No. 2258 Wabash Ave. Captain WILLIAM L. MARSHALL, Corps of Engineers, in charge.

Works.—Improvement of the harbors at Chicago and Calumet, Ill.; of the improvement of the Illinois and Calumet rivers; and of the construction of the

Illinois and Mississippi Canal. To supervise the construction of bridges across the west fork of south branch of Chicago River at Chicago; across Chicago River in West Chicago; across Chicago River between Wells and Clark streets, and east of Wells Street bridge, Chicago; across Calumet River; and across the Illinois River at Kampsville or Columbiana, and at Havana; the alterations of the bridge across south branch of Chicago River near 19th Street, and the rebuilding of the bridges across Calumet River at South Chicago, Ill.

Detroit, Mich.—United States Engineer Office, Telephone Building. Lieutenant-Colonel GARRETT J. LYDECKER, Corps of Engineers, in charge.

Works.—Defensive works at Fort Wayne, Mich. Improvement of the harbors at Michigan City, Ind.; St. Joseph, including Benton Harbor Canal; South Haven, Saugatuck, Holland (Black Lake), Grand Haven, Muskegon, White Lake, Pentwater, Ludington, Manistee, Frankfort, Charlevoix, including entrance to Pine Lake; Petoskey, Cheboygan, Portage Lake, Sand Beach, and Alpena, Mich. Improvement of St. Joseph and Saginaw rivers; Black River at Port Huron, mouth of Black River, Clinton and Rouge rivers; and the construction of turning basin in Rouge River, Mich. Survey of Kalamazoo, Belle, Sebewaing, and Pine rivers, Mich. To supervise the construction of bridges across Rouge River near Detroit; across Muskegon Lake between Muskegon and North Muskegon; across Muskegon River at Muskegon; and across Manistee River, at Manistee, Mich.

Detroit, Mich.—United States Engineer Office, No. 34 West Congress St. Colonel ORLANDO M. POE, Corps of Engineers, in charge.

Works.—Improvement of the St. Marys River at the Falls; the St. Clair Flats Ship Canal; Detroit River, Mich.; Hay Lake Channel of the St. Marys River; and of the ship channel connecting waters of the Great Lakes between Chicago, Duluth, and Buffalo; the construction of dry dock, St. Marys Falls Canal; and dredging at Grosse Point Channel. Charge of St. Clair Flats Ship Canal and St. Marys Falls Canal, Mich. Charge of issuing charts of Northern and Northwestern Lakes, and of water-level observations on Lake Huron.

Cleveland, Ohio.—United States Engineer Office, Hickox Bldg., No. 185 Euclid Ave. Lieutenant-Colonel JARED A. SMITH, Corps of Engineers, in charge.

Works.—Improvement of harbors at Monroe, Mich.; Toledo, Port Clinton, Sandusky, Vermillion, Huron, Cleveland, Fairport, Ashtabula, Conneaut, and mouth of Black River, and of Sandusky River, Ohio. Charge of water-level observations on Lake Erie.

Buffalo, N. Y.—United States Engineer Office, No. 121 Franklin Street, Major ERNEST H. RUFFNER, Corps of Engineers, in charge.

Works.—Improvement of the harbors at Erie, Pa., and Buffalo, Wilson, Olcott, Oak Orchard, and Dunkirk, N. Y. Improvement of Tonawanda Harbor and Niagara River, and of Niagara River from Tonawanda to Port Day, N. Y.

Oswego, N. Y.—United States Engineer Office, Second National Bank Building. Captain DAN C. KINGMAN, Corps of Engineers, in charge.

Works.—Defensive works at Forts Niagara and Ontario, N. Y. Improvement of the harbors at Charlotte, Great Sodus Bay, Little Sodus Bay, Oswego, Sacketts Harbor, and Pultneyville, N. Y. Charge of water-level observations on Lake Ontario.

Burlington, Vt.—United States Engineer Office, No. 8 Church Street, Captain SMITH S. LEACH, Corps of Engineers, in charge.

Works.—Defensive works at Fort Montgomery, New York. Improvement of the harbors at Ogdensburg, N. Y., and Burlington, Vt., and construction of breakwater at Rouses Point, N. Y. Improvement of St. Lawrence, Ticonderoga, and Great Chazy Rivers; of narrows at Lake Champlain, N. Y., and of Otter Creek, Vt. To supervise the construction of bridge across the St. Lawrence River at Morristown, N. Y.

San Francisco, Cal.—United States Engineer Office, No. 533 Kearny Street. * Colonel GEORGE H. MENDELL, Corps of Engineers, in charge.

Works.—Defensive works at Fort Winfield Scott and at Fort Mason, in San Francisco Bay, and of the Battery at San Diego, Cal. Construction of gun and mortar batteries for defense of San Francisco, Cal. Improvement of Oakland Harbor, Cal.

San Francisco, Cal.—United States Engineer Office, Donohoe Building, cor. Market and Taylor Streets. Lieutenant-Colonel WM. H. H. BENYAURD, Corps of Engineers, in charge.

Works.—Defensive works of Alcatraz and Angel Islands, and at Lime Point, Cal. In charge of Yerba Buena Island, San Francisco Harbor, Cal. Improvement of the harbors at Wilmington, San Diego, and San Luis Obispo; of Napa River and Redwood Creek, Cal.; and Colorado River, Ariz. Examination of Colorado River above Yuma, Ariz.

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* Date of retirement from active service, U. S. Army, October 12, 1895.

San Francisco, Cal.—United States Engineer Office, Room 89, Flood Building. Major WILLIAM H. HEUER, Corps of Engineers, in charge.

Works.—Improvement of Humboldt Harbor and Bay; of the Sacramento and Feather rivers, including treatment of the Yuba River near and above Marysville, and of Bear River, San Joaquin and Mokelumne rivers, and Petaluma Creek, Cal. Examination of San Joaquin and American rivers, and Steamboat Channel and from junction thereof with Sacramento River to mouth of said river, Cal. To supervise the construction of bridge across Mormon Channel at Otter Street, Stockton, Cal.

Portland, Ore.—United States Engineer Office, Worcester Building. No. 68 Third Street. Captain THOMAS W. SYMONS, Corps of Engineers, in charge.

Works.—Improvement of harbor at Yaquina Bay, entrance to harbor at Nehalem Bay, mouth of Siuslaw River, Umpqua and Coquille Rivers, Upper Coquille River, between Coquille City and Myrtle Point, Tillamook Bay, entrance and harbor at Coos Bay, Oreg.; the Upper Columbia and Snake rivers, Oreg. and Wash.; Upper Snake River between Huntington Bridge and Seven Devils mining district, Idaho; Olympia Harbor, Grays Harbor and Chehalis River; the Columbia River from the head of Rock Island Rapids to Foster Creek Rapids; Puget Sound and its tributary waters; Swinomish Slough, and Willapa River and Harbor; dredging Everett Harbor, including mouth of Snohomish River, and Snohomish River from mouth to Lowell, and dredging Salmon Bay, and the improvement of the waterway connecting the waters of Puget Sound, at Salmon Bay, with Lakes Union and Washington by enlarging the said waterway into a ship-canal, Wash. Survey of Grays Harbor and its bar entrance, and Columbia River, Wash. Examination of Flathead, Kootenai, and Pend d'Oreille rivers, Mont., and North River, Wash. To exercise supervision over the construction of bridges across Clearwater River above Lewiston, Idaho; across D'Wamish River, near Seattle; over the Ship Channel at Tacoma; and across Stillaquamish River, Wash.

Portland, Ore.—United States Engineer Office, No. 73 Fourth Street. Major JAMES C. POST, Corps of Engineers, in charge.

Works.—Defensive works at Forts Stevens, Oreg., and Canby, Wash. Improvement of the Canal at the Cascades of the Columbia River, mouth of the Columbia River, Columbia River, Oreg. and Wash., at Three-Mile Rapids, and the construction and equipment of a boat railway from the foot of The Dalles Rapids to the head of Celilo Falls, Willamette River above Portland, including the removal of obstructions in Yamhill River up to McMinnville; Lower Willamette River in front of and below Portland, Oreg., and Columbia River below the Willamette River, Oreg. and Wash.; Youngs and Klaskuine rivers, Oreg.; Columbia River, between the mouth of the Willamette River and the city of Vancouver, and of the Cowlitz River, Wash. In charge of gauging waters of the Columbia River, measuring tidal and river volumes. Survey of Yamhill, Columbia, and Willamette rivers, Oreg. To supervise the construction of bridge across the Willamette River at Portland; across Young's Bay, Oreg.; across the Columbia River near Vancouver; across the east fork of Lewis River at La Center, and across Skamokawa Creek, Wash.

BOARDS AND COMMISSIONS.

Board of Ordnance and Fortification.

Lieut.-Gen. JOHN M. SCHOFIELD, Commanding U. S. Army, President. Washington, D. C.

* Colonel HENRY L. ABBOT, Corps of Engineers, Bvt. Brig.-Gen. U. S. A., Army Building, New York.

Colonel ROYAL T. FRANK, 1st Artillery, Fort Monroe, Va.

Major FRANK H. PHIPPS, Ordnance Department, U. S. A., Governors Island, New York, N. Y.

Hon. JOSEPH H. OUTHWAITE, Columbus, Ohio.

Captain J. C. AYRES, Ordnance Department, U. S. A., Recorder of the Board, Governor's Island, New York, N. Y.

The Board of Engineers.

* Colonel HENRY L. ABBOT, President, Army Building, New York.

Colonel HENRY M. ROBERT, Army Building, New York.

Lieut.-Col. PETER C. HAINS, Light-House Depot, Tompkinsville, New York.

Lieut.-Col. GEORGE L. GILLESPIE, Army Building, New York.

Member when considering fortifications of Pacific Coast: † Colonel GEORGE H. MENDELL, 533 Kearny St., San Francisco, Cal.

Member when considering fortifications of South Atlantic Coast: Colonel WILLIAM P. CRAIGHILL, 9 Pleasant St., Baltimore, Md.

Mississippi River Commission. (Created by Act of Congress of June 28, 1879.)

Lieut.-Colonel GEO. L. GILLESPIE, President, Army Building, New York.

Lieut.-Colonel CHARLES R. SUTER, 1515 Lucas Place (Locust St.), St. Louis, Mo.

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* Date of retirement from active service, U. S. Army, August 13, 1895.

† Date of retirement from active service, U. S. Army, October 12, 1895.

Lieut.-Colonel AMOS STICKNEY, Custom-House, Cincinnati, O.
B. M. HARROD, No. 19 Masonic Building, New Orleans, La.
R. S. TAYLOR, Fort Wayne, Ind.
HENRY FLAD, C.E., 3400 Franklin Ave., St. Louis, Mo.
HENRY L. WHITING, U. S. Coast and Geodetic Survey, Washington, D. C.
Captain GEORGE A. ZINN, Secretary and Disbursing Officer, and Secretary and Assistant to the Construction Committee, and Disbursing Officer for Works carried on by the Commission, No. 2732 Pine St., St. Louis, Mo.

Missouri River Commission. (Created by Act of Congress of July 5, 1884.)

Lieut.-Colonel CHARLES R. SUTER, President, 1515 Lucas Place (Locust St.), St. Louis, Mo.
Lieut.-Colonel ALEXANDER MACKENZIE, Rock Island, Ill.
Major CHARLES J. ALLEN, Custom-House, St. Louis, Mo.
G. C. BROADHEAD, Missouri State University, Columbia, Mo.
R. S. BERLIN, Continental Block, Omaha, Neb.
Lieut. JAMES C. SANFORD, Secretary and Disbursing Officer, 1515 Lucas Place (Locust St.), St. Louis, Mo.

California Debris Commission, to regulate Hydraulic Mining in the State of California. (Created by Act of Congress of March 1, 1893.)

* Colonel GEORGE H. MENDELL, President, No. 533 Kearny St., San Francisco, Cal.
Lieut.-Col. WM. H. H. BENYAURD, Donohoe Building, corner Market and Taylor Sts., San Francisco, Cal.
Major WM. H. HEUER, Room 89, Flood Building, San Francisco, Cal.
Lieut. CASSIUS E. GILLETTE, Disbursing Officer, Room 92, Flood Building, San Francisco, Cal.

Lake Erie and Ohio River Canal Board.

Colonel ORLANDO M. POE, 34 West Congress St., Detroit, Mich.
Lieut.-Colonel AMOS STICKNEY, Custom-House, Cincinnati, Ohio.
Captain WILLIAM L. MARSHALL, No. 2258 Wabash Ave., Chicago, Ill.
Lieut. HIRAM M. CHITTENDEN, Executive and Disbursing Officer, Room 44, Journal Building, Columbus, Ohio.

* Date of retirement from active service, U. S. Army, October 12, 1895.

Board on Building and Repair of Levees on Mississippi River.

Captain GEORGE MCC. DERBY, No. 1 Prytannia St., New Orleans, La.
Captain CURTIS MCD. TOWNSEND, No. 106 Madison St., Memphis, Tenn.
Captain GRAHAM D. FITCH, No. 99 Madison St., Memphis, Tenn.

Public Buildings and Grounds in District of Columbia under Engineer Department.

Colonel JOHN M. WILSON, Corps of Engineers, in charge. Office: Room 24, War Department, Washington, D. C.

Works.—Charge of Public Buildings and Grounds in the District of Columbia, with the rank of Colonel. Charge of the preservation, care, and safety of buildings occupied by the War Department in the District of Columbia. Charge of Government telegraph lines connecting the Capitol with the various Departments and the Government Printing Office. Charge of repairs to the Government Printing Office building and construction of new Printing Office Building. Charge of the disbursement of the funds for and the construction of Pedestal and Statue of Gen. John A. Logan, and of the Foundation and Pedestal of the Statue of Gen. Winfield S. Hancock, to be erected in the city of Washington. Charge of the erection of a Monument at the Birthplace of Washington and the construction of an iron pile dock as a means of approach to the same.

Washington Aqueduct.

Major JOHN G. D. KNIGHT, Corps of Engineers, in charge. Office: No. 2728 Pennsylvania Ave., Washington, D. C.

Works.—Charge of the Washington Aqueduct; increasing the water supply of the city of Washington, and of the disbursement of funds pertaining to the erection of fishways at Great Falls of the Potomac.

Colonel GEORGE H. ELLIOT, Corps of Engineers, retired. Office: No. 2728 Pennsylvania Ave., Washington, D. C.

Works.—Charge of the Dalecarha receiving reservoir of the Washington Aqueduct.

WORKS UNDER QUARTERMASTER'S DEPARTMENT.

ARMY POSTS.

Corrected to March 1, 1895.

The officer detailed as Post Quartermaster is liable to be changed at any time. Communications may be addressed "Post Quartermaster," etc., etc., without naming the officer.

Quartermaster-General's Office, War Department, Washington, D. C.
Brigadier-General R. N. BATCHELDER, Quartermaster-General.

Assistants in Office of Quartermaster-General:

Lieut.-Col. G. H. WEEKS, Dep. Q. M. Gen.
Assisting the Quartermaster-General in administrative business of the office and in charge of matters pertaining to finance, money and property accounts, clothing and equipage returns, inspection, and clothing and equipage supplies.

Major D. D. WHEELER, Q. M.
In charge of matters pertaining to transportation and regular supplies; also conducting fuel tests, Q. M. G. O.

Captain W. S. PATTEN, A. Q. M.
In charge of matters pertaining to mail and record; records, files, and claims; National Cemeteries.

Captain C. P. MILLER, A. Q. M.
In charge of matters pertaining to barracks and quarters and construction and repairs.

Captain O. F. LONG, A. Q. M.
In charge of matters relating to lighting and heating, sewerage, and plumbing at military posts.

POSTS AND POST QUARTERMASTERS.

DEPARTMENT OF THE EAST.

Adams, Fort, R. I. Lieut. E. M. Weaver, 2d Art.
Barrancas, Fort, Fla. Lieut. D. J. Rumbough, 3d Art.
Columbus, Fort, N. Y. Lieut. H. L. Bailey, 21st Inf.
Columbus Barracks, Ohio. Major Charles Bird, Q. M.
Davids Island, N. Y. Capt. J. W. Summerhayes, A. Q. M.
Ethan Allen, Fort, Vt. Lieut. J. W. Heard, 3d Cav. Capt. Guy Howard, A. Q. M., in charge of construction.
Hamilton, Fort, N. Y. Lieut. C. J. Bailey, 1st Art.
Jackson Barracks, La. Lieut. Geo. LeR. Irwin, 3d Art.
Key West Barracks, Fla. Lieut. J. M. Califf, 3d Art.
Madison Barracks, N. Y. Lieut. F. L. Dodds, 9th Inf. Lieut. Geo. Palmer, 9th Inf. In charge of construction during absence of Capt. C. B. Thompson, A. Q. M.
McHenry, Fort, Md. Lieut. A. Cronkhite, 4th Art.
McPherson, Fort, Ga. Lieut. F. C. Kimball, 5th Inf.
Monroe, Fort, Va. Capt. J. W. Pullman, A. Q. M.
Myer, Fort, Va. Lieut. Thos. Cruse, 6th Cav.
Newport, Ky., Lieut. R. B. Turner, 6th Inf.
Niagara, Fort, N. Y. Lieut. C. S. Hall, 13th Inf.
Plattsburgh Barracks, N. Y. Lieut. E. H. Brooke, 21st Inf. Capt. G. E. Pond, A. Q. M., in charge of construction.
Porter, Fort, N. Y. Lieut. W. N. Hughes, 13th Inf.
Preble, Fort, Me. Lieut. J. H. Gifford, 2d Art.
Schuyler, Fort, N. Y. Lieut. M. Crawford, 2d Art.
St. Francis Barracks, Fla. Lieut. C. G. Woodward, 3d Art.
Thomas, Fort, Ky. Lieut. C. G. Morton, 6th Inf.
Trumbull, Fort, Conn. Lieut. H. A. Reed, 2d Art.
Wadsworth, Fort, N. Y. Lieut. R. H. Patterson, 1st Art.
Warren, Fort, Mass. Lieut. L. Ostheim, 2d Art.
Washington Barracks, D. C. Lieut. Ira A. Haynes, 4th Art.
West Point, N. Y. Capt. J. B. Bellinger, A. Q. M.
Willets Point, N. Y. Lieut. Edgar Jadwin, Corps of Engineers.

DEPARTMENT OF THE MISSOURI.

Brady, Fort, Mich. Lieut. B. M. Purssell, 19th Inf.
Hot Springs, Ark. Lieut. L. D. Greene, 7th Inf.
Jefferson Barracks, Mo. Capt. S. R. Jones, A. Q. M.
Leavenworth, Fort, Kans. (Mil. Prison). Lieut. Geo. B. Davis, 4th Inf.
Leavenworth, Fort, Kans. (Post). Capt. F. G. Hodgson, A. Q. M.
Little Rock, Ark. Capt. R. R. Stevens, A. Q. M.
Mackinac, Fort, Mich. Lieut. W. Geary, 19th Inf.
Reno, Fort, O. T. Lieut. J. H. Shollenberger, 10th Inf.
Riley, Fort, Kansas. Capt. W. H. Miller, A. Q. M.
Sheridan, Fort, Ill. Capt. F. B. Jones, A. Q. M.
Sill, Fort, O. T. Lieut. J. A. Harman, 7th Cav.
Supply, Fort, O. T. Lieut. F. E. Lacey, Jr., 10th Inf.
Wayne, Fort, Mich. Lieut. H. L. Roberts, 19th Inf. Capt. George Ruhlen, A. Q. M., in charge of construction, No. 1688 River St., Detroit, Mich.

DEPARTMENT OF THE PLATTE.

Crook, Fort, Neb. Major C. F. Humphrey, Q. M., Omaha, Neb.
D. A. Russell, Fort, Wyo. Lieut. E. N. Jones, 8th Inf.
Niobrara, Fort, Neb. Lieut. D. E. McCarthy, 12th Inf.
Omaha, Fort, Neb. Lieut. H. H. Benham, 2d Inf.
Robinson, Fort, Neb. Lieut. E. F. Ladd, 9th Cav.
Washakie, Fort, Wyo. Lieut. T. Norman, 8th Inf.

DEPARTMENT OF DAKOTA.

Assinniboine, Fort, Mont. Lieut. J. B. McDonald, 10th Cav.
Buford, Fort, N. Dak. Capt. H. P. Ritzins, 25th Inf.
Custer, Fort, Mont. Lieut. W. H. Hay, 10th Cav.
Harrison, Fort, Helena, Mont. Capt. G. S. Hoyt, A. Q. M.
Keogh, Fort, Mont. Lieut. R. N. Getty, 22d Inf.
Meade, Fort, S. Dak. Lieut. C. C. Walcutt, Jr., 8th Cav.
Missoula, Fort, Mont. Lieut. A. B. Shattuck, 25th Inf.
Pembina, Fort, N. Dak. H. E. Ely, 22d Inf.
Snelling, Fort, Minn. Lieut. W. C. Buttler, 3d Inf.
Yates, Fort, N. Dak. Lieut. W. E. Ayer, 12th Inf.
Yellowstone, Fort, Wyo. Lieut. W. W. Forsyth, 6th Cav.

DEPARTMENT OF TEXAS.

Bliss, Fort, Texas. Lieut. E. S. Avis, 18th Inf.
Brown, Fort, Texas. Lieut. H. J. Goldman, 5th Cav.
Clark, Fort, Texas. Lieut. W. A. Nichols, 23d Inf.
Eagle Pass, Camp, Texas, Lieut. L. W. Cornish, 5th Cav.
Hancock, Fort, Texas. Capt. H. Jackson, 7th Cav.
McIntosh, Fort, Texas. Lieut. H. T. Ferguson, 23d Inf.
Ringgold, Fort, Texas, Lieut. S. E. Adair, 5th Cav.
Sam Houston, Fort, Texas. Lieut. G. W. Read, 5th Cav.

DEPARTMENT OF CALIFORNIA.

Alcatraz Island, Cal. Lieut. O. E. Wood, 5th Art.
Angel Island, Cal. Lieut. F. O. Ferris, 1st Inf.
Benecia Barracks, Cal. Lieut. H. A. Smith, 1st Inf.
Mason, Fort, Cal. Lieut. P. C. March, 5th Art.
Presidio, San Francisco, Cal. Capt. J. E. Sawyer, A. Q. M.
San Diego Barracks, Cal. Lieut. A. H. Martin, 1st Inf.

DEPARTMENT OF THE COLORADO.

Apache, Fort, Ariz. Lieut. H. R. Lee, 11th Inf.
Bayard, Fort, N. M. Lieut. J. E. Brett, 24th Inf.
Douglas, Fort, Utah. Lieut. W. K. Wright, 16th Inf.
Du Chesne, Fort, Utah. Lieut. L. M. Koehler, 9th Cav.
Grant, Fort, Ariz. Lieut. G. H. Macdonald, 1st Cav.
Huachuca, Fort, Ariz. Lieut. Geo. S. Cartwright, 24th Inf.
Logan, Fort, Colo. Lieut. Geo. S. Young, 7th Inf.
San Carlos, A. T. Lieut. L. P. Davison, 11th Inf.
Stanton, Fort, N. Mex. Lieut. E. S. Wright, 1st Cav.
Whipple Barracks, Ariz. Lieut. R. M. Blatchford, 11th Inf.
Wingate, Fort, N. Mex. Lieut. C. B. Hoppin, 2d Cav.

DEPARTMENT OF THE COLUMBIA.

Boise Barracks, Idaho. Lieut. R. D. Walsh, 4th Cav.
Canby, Fort, Wash. Lieut. E. T. Brown, 5th Art.
Sherman, Fort, Idaho. Lieut. E. H. Brown, 4th Inf.
Spokane, Fort, Wash. Lieut. F. B. Andrews, 4th Inf.
Townsend, Fort, Wash. Lieut. O. E. Hunt, 14th Inf.
Vancouver Barracks, Wash. Lieut. H. C. Cabell, 14th Inf.
Walla Walla, Fort, Wash. Lieut. R. A. Brown, 4th Cav.

ARSENALS.

Allegheny Arsenal, Pa. Capt. M. J. Grealish, Ord. Dept.
Augusta Arsenal, Ga. Major J. G. Butler, Ord. Dept.
Benecia Arsenal, Cal. Lieut. O. M. Lissak, Ord. Dept.
Columbia Arsenal, Tenn. Capt. J. E. Greer, Ord. Dept.
Frankford Arsenal, Pa. Capt. C. H. Clark, Ord. Dept.
Indianapolis Arsenal, Ind. Major A. L. Varney, Ord. Dept.
Kennebec Arsenal, Maine. Major J. R. McGinness, Ord. Dept.
Rock Island Arsenal, Ills. Lieut. O. C. Horney, Ord. Dept.
Sandy Hook Proving Ground, N. J. Lieut. C. L'H. Ruggles, Ord. Dept.
St. Louis Powder Depot, Mo. Major J. A. Kress, Ord. Dept.
Springfield Armory, Mass. Major W. H. Rexford, Ord. Dept.
U. S. Powder Depot, Dover, N. J. Col. J. M. Whittemore, Ord. Dept.
Watertown Arsenal, Mass. Capt. Frank Baker, Ord. Dept.
Watervliet Arsenal, N. Y. Lieut. W. S. Peirce, Ord. Dept.

QUARTERMASTERS' DEPOTS.

Jeffersonville, Ind. Lieut.-Col. A. G. Robinson, D. Q M. G.
New York City, N. Y., Army Building, Whitehall St. Col. J. M. Moore, A. Q. M. G.
Philadelphia, Pa., 1428 Arch Street. Lieut.-Col. A. F. Rockwell, D. Q. M. G.
San Francisco, Cal., 36 New Montgomery Street. Lieut.-Col. J. G. C. Lee, D. Q. M. G.
St. Louis, Mo., old Custom-House Building. Lieut.-Col. J. Gilliss, D. Q. M. G.
Washington, D. C., War Department. Major C. R. Barnett, Q. M.

WORKS UNDER TREASURY DEPARTMENT.

SECRETARY OF THE TREASURY,
HON. JOHN G. CARLISLE,
Treasury Building, Washington, D. C.

LIGHT-HOUSE DISTRICTS, ENGINEERS, AND INSPECTORS.

The officers detailed for duty as Light-House Engineers and Inspectors are liable to be changed at any time. Communications may be addressed "U. S. Light-House Engineer, District," or "U. S. Light-House Inspector, District," etc., etc.

LIGHT-HOUSE BOARD.

Office: Treasury Department Building.

Hon. John G. Carlisle, Secretary of the Treasury and *ex-officio* President of the Board, Treasury Department, Washington, D. C.

Rear-Admiral John G. Walker, U. S. N., Chairman, 1202 Eighteenth Street, N. W., Washington, D. C.

Mr. Walter S. Franklin, 24 East Mount Vernon Place, Baltimore, Md.

Mr. W. W. Duffield, Superintendent U. S. Coast and Geodetic Survey, Washington, D. C.

Colonel John M. Wilson, Corps of Engineers, U. S. A., War Department, Washington, D. C.

Captain George Dewey, U. S. N., 1730 H Street, N. W., Washington, D. C.

Major Henry M. Adams, Corps of Engineers, U. S. A., War Department, Washington, D. C.

Commander George F. F. Wilde, U. S. N., Naval Secretary, Treasury Department, Washington, D. C.

Captain John Millis, Corps of Engineers, U. S. A., Engineer Secretary, Treasury Department, Washington, D. C.

FIRST DISTRICT.

The first district extends from the head of navigation in the St. Croix River, Maine, the eastern boundary of the United States, to and including Hampton Harbor, New Hampshire, and includes all the aids to navigation on the coasts and in the navigable bays, rivers, and inlets of Maine and New Hampshire.

Engineer.—Major William R. Livermore, Corps of Engineers, U. S. A., Rooms 141 and 142 Post-Office Building, Boston, Mass.

Inspector.—Commander George E. Wingate, U. S. N., Custom-House, Portland, Me.

SECOND DISTRICT.

The second district extends from Hampton Harbor, New Hampshire, to, but does not include, Elisha Ledge, off Warren Point, Rhode Island, and embraces all the aids to navigation on the coast of Massachusetts except a small portion of Narragansett Bay and Taunton River.

Engineer.—Major William R. Livermore, Corps of Engineers, U. S. A., Rooms 141 and 142, Post-Office Building, Boston, Mass.

Inspector.—Captain Francis M. Green, U. S. N., Post-Office Building, Boston, Mass.

THIRD DISTRICT.

The third district includes and extends from Elisha Ledge, off Warren Point, Rhode Island, to a point on the coast of New Jersey, opposite Shrewsbury Rocks, and embraces all aids to navigation on the sea and sound coast of Rhode Island, Connecticut, and New York, and of New Jersey above the Highlands of Navesink; Mount Hope, Narragansett, and New York bays; Providence, Connecticut, Thames, Raritan, and Hudson rivers; Whitehall Narrows and lakes Champlain and Memphremagog.

Engineer.—Lieut.-Col. Peter C. Hains, Corps of Engineers, U. S. A., Tompkinsville, Staten Island, N. Y.

Inspector.—Captain Winfield S. Schley, U. S. N., Tompkinsville, Staten Island, N. Y.

FOURTH DISTRICT.

The fourth district extends from Shrewsbury River, New Jersey, to and including Metomkin Inlet, Virginia, and embraces all the aids to navigation on the sea-coast of New Jersey below the Highlands of Navesink, on the Delaware Bay, the Delaware and Schuylkill rivers, the sea-coasts of Delaware and Maryland, and part of the sea-coast of Virginia.

Engineer.—Major Charles W. Raymond, Corps of Engineers, U. S. A., Post-Office Building, Philadelphia, Pa.

Inspector.—Commander George C. Reiter, U. S. N., Post-Office Building, Philadelphia, Pa.

FIFTH DISTRICT.

The fifth district extends from Metomkin Inlet, Virginia, to include New River Inlet, North Carolina, and embraces part of the sea-coasts of Virginia and North Carolina, all of Chesapeake Bay, the sounds of North Carolina, and the rivers tributary thereto.

Engineer.—Captain Eric Bergland, Corps of Engineers, U. S. A., Post-Office Building, Baltimore, Md.

Inspector.—Commander Benjamin P. Lamberton, U. S. N., Post-Office Building, Baltimore, Md.

SIXTH DISTRICT.

The sixth district extends from New River Inlet, North Carolina, to and including Jupiter Inlet, Florida, and includes all the aids to navigation within these limits on the coasts and in the bays, rivers, and harbors of North Carolina, South Carolina, Georgia, and Florida.

Engineer.—Captain Eric Bergland, Corps of Engineers, U. S. A., Post-Office Building, Baltimore, Md., and Southern Wharf, Charleston, S. C. B. B. Smith, Asst. Engineer, Charleston, S. C.

Inspector.—Commander Morris R. S. Mackenzie, U. S. N., Brown's Wharf, Charleston, S. C.

SEVENTH DISTRICT.

The seventh district extends from just south of Jupiter Inlet, Florida, to the mouth of Perdido River, Florida, and includes all aids to navigation on the Atlantic and Gulf coasts of Florida within these limits.

Engineer.—Major James B. Quinn, Corps of Engineers, U. S. A., 349 Carondelet Street, New Orleans, La.

Inspector.—Commander William B. Newman, U. S. N., Navy-yard, Pensacola, Fla.

EIGHTH DISTRICT.

The eighth district extends from the mouth of the Perdido River, the boundary between Florida and Alabama, to the Rio Grande, the southwestern boundary of Texas, and includes all aids to navigation on the Gulf coast of the United States within these limits, together with those in lakes Borgne, Pontchartrain, Maurepas, Grand Lake, and Lake Chicot, and those on the Mississippi River below New Orleans, La.

Engineer.—Major James B. Quinn, Corps of Engineers, U. S. A., 349 Carondelet Street, New Orleans, La.

Inspector.—Commander Joseph B. Coghlan, U. S. N., Custom-House, New Orleans, La.

NINTH DISTRICT.

The ninth district includes all aids to navigation on Lake Michigan, Green Bay, and tributary waters, and the Straits of Mackinac, west of a line drawn across the straits from Old Mackinac Point.

Engineer.—Major Milton B. Adams, Corps of Engineers, U. S. A., 18 Bagley Avenue, Detroit, Mich.

Inspector.—Commander James H. Dayton, U. S. N., Room 1308 Chamber of Commerce Building, corner Washington and La Salle Streets Chicago, Ill.

TENTH DISTRICT.

The tenth district extends from the mouth of the St. Regis River, New York, to the River Rouge, Detroit River, Michigan, and embraces all the aids to navigation on the American shores and waters of lakes Ontario and Erie, and the St. Lawrence, Niagara, and lower part of Detroit rivers.

Engineer.—Lieut.-Col. Jared A. Smith, Corps of Engineers, U. S. A., Hickok Building, 185 Euclid Avenue, Cleveland, Ohio.

Inspector.—Commander Charles V. Gridley, U. S. N., Post-Office Building, Buffalo, N. Y.

ELEVENTH DISTRICT.

The eleventh district extends from the River Rouge, Detroit River, to the head of Lake Superior, and covers the American shores and waters above the River Rouge, of the Detroit and St. Clair rivers, lakes St. Clair, Huron, and Superior, St. Mary's River, and the portion of the Straits of Mackinac eastward of a line from Old Mackinac Point.

Engineer.—Major Milton B. Adams, Corps of Engineers, U. S. A., 18 Bagley Avenue, Detroit, Mich.

Inspector.—Commander William W. Mead, U. S. N., 80 Griswold Street, Detroit, Mich.

TWELFTH DISTRICT.

The twelfth district extends from the boundary-line between California and Mexico to the boundary between California and Oregon, and embraces all the aids to navigation on the sea-coast, bays, and navigable rivers of California.

Engineer.—Major William H. Heuer, Corps of Engineers, U. S. A., Room 89, Flood Building, San Francisco, Cal.

Inspector.—Commander Henry E. Nichols, U. S. N., Room 77, Appraiser's Building, San Francisco, Cal.

THIRTEENTH DISTRICT.

The thirteenth district extends from the southern boundary of Oregon to the boundary-line between the United States and British Columbia, and embraces all the aids to navigation on the Pacific coast of Oregon and Washington, and the Columbia and Willamette rivers, Strait of Juan de Fuca, Puget Sound, and Alaskan waters.

Engineer.—Major James C. Post, Corps of Engineers, U. S. A., 73 Fourth Street, Portland, Oregon.

Inspector. — Commander Oscar W. Farenholt, U. S. N., 623–25 Marquam Building, Portland, Oregon.

FOURTEENTH DISTRICT.

The fourteenth district extends on the Ohio River, from Pittsburg, Pa., to Cairo, Ill., 966 miles; on the Tennessee River, 255½ miles; and on the Great Kanawha River, 73½ miles, and embraces all the aids to navigation within these limits.

Engineer.—Lieut.-Col. Amos Stickney, Corps of Engineers, U. S. A., Custom-House, Cincinnati, Ohio.

Inspector.—Lieut.-Commander Frederick W. Crocker, U. S. N., Post-Office Building, Cincinnati, Ohio.

FIFTEENTH DISTRICT.

The fifteenth district extends on the Mississippi River from the head of navigation to Cairo, Ill., on the Missouri River to Kansas City, Mo., and on the Illinois River from La Salle to its mouth, and embraces all the aids to navigation within these limits.

Engineer.—Lieut.-Col. Charles R. Suter, Corps of Engineers, U. S. A., 1515 Lucas Place, St. Louis, Mo.

Inspector.—Lieut.-Commander Abraham B. H. Lillie, U. S. N., New Custom-House, St. Louis, Mo.

SIXTEENTH DISTRICT.

The sixteenth district extends on the Mississippi River from Cairo, Ill., to New Orleans, La., and on the Red River a distance of 8 miles, and embraces all the aids to navigation within these limits.

Engineer.—Lieut.-Col. Charles R. Suter, Corps of Engineers, U. S. A., 1515 Lucas Place, St. Louis, Mo.

Inspector.—Commander Andrew J. Iverson, U. S. N., Custom-House, Memphis, Tenn.

SUPERVISING ARCHITECT'S OFFICE.

Supervising Architect, Treasury Department.—William Martin Aiken, Treasury Department, Washington, D. C.

Chief Executive Officer.—C. V. Kemper, Treasury Department, Washington, D. C.

Communications for the officer of the Treasury Department in charge of any completed public building under the Department can be addressed "Custodian U. S. Custom-House," etc., etc.

The officer in charge of an uncompleted building may be addressed as "Superintendent of Construction, U. S. Building," etc., etc.

For lists of federal buildings in charge of the Treasury Department see pp. 150 and 159.

LIFE-SAVING SERVICE.

General Superintendent.—S. I. Kimball, Treasury Department, Washington, D. C.

Assistant General Superintendent.—J. K. Upton, Treasury Department, Washington, D. C.

Superintendents of Construction.—Captain C. A. Abbey, U. S. R. C. S., 24 State Street, New York, N. Y. Captain Geo. W. Moore, U. S. R. C. S., Custom-house, Baltimore, Md.

DISTRICTS, LIFE-SAVING SERVICE.

First District—Coasts of Maine and New Hampshire.—District Superintendent: John M. Richardson, Portland, Me.

Second District—Coast of Massachusetts.—District Superintendent: Benjamin C. Sparrow, East Orleans, Mass.

Third District—Coasts of Rhode Island and Long Island.—District Superintendent: Arthur Dominy, Bay Shore, New York. Assistant Superintendent: Herbert M. Knowles, Wakefield, R. I.

Fourth District—Coast of New Jersey.—District Superintendent: John G. W. Havens, Point Pleasant, New Jersey.

Fifth District—Coasts of Delaware, Maryland, and Virginia.—District Superintendent: Benjamin S. Rich, Daugherty, Accomac Co., Va.

Sixth District—Coasts of Virginia and North Carolina. — District Superintendent: Patrick H. Morgan, Shawboro, North Carolina.

Seventh District—Coasts of South Carolina, Georgia, and Florida.—District Superintendent: Hiram B. Shaw, Ormond, Florida.

Eighth District—Coast of Gulf of Mexico.—District Superintendent: William A. Hutchings, Galveston, Texas.

Ninth District—Coasts of Lakes Ontario and Erie.—District Superintendent : Edwin E. Chapman, Buffalo, New York.

Tenth District—Coasts of Lakes Huron and Superior.—District Superintendent : Jerome G. Kiah, Sand Beach, Michigan.

Eleventh District—Coast of Lake Michigan.—District Superintendent: Nathaniel Robbins, Grand Haven, Michigan.

Twelfth District—Coasts of Washington, Oregon, and California.—District Superintendent : Thomas J. Blakeney, Room 35, Appraiser's New Building, San Francisco, Cal.

DISTRICT OF COLUMBIA.

District Offices.—Walker Building, Louisiana Ave., N. W., Washington, D. C.

Commissioners.—John W. Ross, Myron M. Parker, and Charles F. Powell, Major, Corps of Engineers, U. S. A.

Assistants to Engineer Commissioner.

Captain Gustav J. Fiebiger, Corps of Engineers, U. S. A. Charged with supervision of surface work, roads, pavements, etc.

Captain Edward Burr, Corps of Engineers, U. S. A. Charged with the supervision of the water department, street-lighting, etc.

Captain Lansing H. Beach, Corps of Engineers, U. S. A. Charged with the supervision of the sewer department, plumbing, etc.

BUILDING FOR LIBRARY OF CONGRESS.

Office : 145 *East Capitol Street.*

Brigadier-General Thomas Lincoln Casey, in charge.
Bernard R. Green, Engineer and Superintendent.

DIRECTORY OF CONTRACTORS.

Compiled from official returns of bidders on public works.

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DREDGING.

Alabama Dredging and Jetty Co., Montgomery, Ala.
American Dredging Co., Philadelphia, Pa.
Anthony, Chas. W., Fall River, Mass.
Ashley, W. H., Toledo, O.
Atlantic Contracting Co., New York, N. Y.
Atlantic Dredging Co., New York, N. Y.
Atlas Dredging Co., Wilmington, Del.
Bailey, B. G., Philadelphia, Pa.
Baker, G. K., Berkley, Va.
Baltimore Dredging Co., Baltimore, Md.
Barker, Chas. S., West Superior, Wis.
Bay City Dredging Co., Bay City, Mich.
Beardsley, Alonzo J., Bridgeport, Conn.
Benton, Thos. H., Elizabethport, N. J.
Bochman, Chas. G., Charleston, S. C.
Bowers Dredging Co., Portland, Ore.
Boynton Bros., Boston, Mass.
Brainard, Elijah, New York, N. Y.
Breyman Bros., Toledo, O.
Brown, H. S., Quincy, Ill.
Brummelkamp, P. J., Syracuse, N. Y.
Bryan, Jas. A., River View and Tampa, Fla.
Burgwyn, C. P. E., Richmond, Va.
Caler, Chester T., Norfolk, Va.
Carberry, John C., Philadelphia, Pa.
Chandler, F. S., Toledo, O.
Chicago Dredging and Dock Co., Chicago, Ill.
Clarke, Chas., Galveston, Tex.
Condon, Dan., South Omaha, Neb.
Conlon & Garner, Thorold, Ontario, Can.
Crouch, Haswell W., Charleston, S. C.
Culpepper, H. E., Portsmouth, Va.
Curtis, John A., Richmond, Va.
Daly, Wm. J., Ogdensburg, N. Y.
Dixon, S. O., Racine, Wis.
Drews, F. C., Chicago, Ill.
Du Bois, Chas. & H. E., New York, N. Y.
Dunbar & Sullivan, Sault Ste. Marie, Mich.; Buffalo, N. Y.
Edwards, Howlett & Thompson, New York, N. Y.
Egan, Geo. W., Charleston, S. C.
Fenner, J. H., Jersey City, N. J.
Finch, Robert, Grand Haven, Mich.
Fraser, Simon C., New London, Conn.
Friday, Jacob, Pittsburg, Pa.
Gaynor, Edw. H., Fayetteville, N. J.
Geiger & Zabriskie, Tacoma, Wash.
Geo. C. Fobes & Co., Baltimore, Md.
Goodsell, E. R., Plattsburg, N. Y.
Gostlin, Wm. H., Hammond, Ind.
Grant, Colin McK., Charleston, S. C.
Green Bay Dredge and Pile-driver Co., Green Bay, Wis.
Green's Dredging Co., Chicago, Ill.
Groh & Walter, Sheboygan, Wis.
Hackett, John, San Francisco, Cal.
Hall, Edmund, Detroit, Mich.
Hamilton & Sawyer, Cumberland Co., Me.
Hamilton, Robert, Chebeague, Me.
Hartford Dredging Co., Hartford, Conn.
Hess, Julius, Detroit, Mich.
Hingston, Ed. J., Buffalo, N. Y.
Hoag & Co., Cincinnati, O.
Howard, Henry, Port Huron, Mich.
Hubbell, Th. M., Detroit, Mich.
H. W. Hubbell & Co., Saginaw, Mich.
Hyatt, Frank A., Beaumont, Tex.
International Contracting Co., New York, N. Y.
Johnson, Willard, Fulton, N. Y.
Kern, Daniel, Portland, Ore.
Killeen, John, New Liberty, Iowa.
King & Nelson, Des Moines, Iowa.
King, Charles, Tacoma, Wash.
Kirk, W. A., Madison, Ind.
Langhorne, C. D., Richmond, Va.
Levy, Gustav G., Galveston, Tex.
Lewis, O. E., Winthrop, Mass.
Lockerbie, Geo., Detroit, Mich.
Loud, H. N., Au Sable, Mich.
Lovering, Edgar P., South Boston, Mass.
L. P. & J. A. Smith, Cleveland, O.
Lydon, Wm. A., Chicago, Ill.
Lynch & Hannan, Ogdensburg, N. Y.
Lynch, John D., Monmouth, Ill.
Lynn Dredging Co., Lynn, Mass.
Madison, John H., Baltimore, Md.
Martin, Augustus B., Boston, Mass.
Mason, Hoge & Dunn, Frankfort, Ky.
Masterton, Branch T., Galveston, Tex.
McCallum, Lee, New York, N. Y.
McCauley, W. F., Savannah, Ga.
McCollum & Lee, Essexville, Mich.
McCanville, D., Washington, D. C.
McDuff, W. A., Jacksonville, Fla.
McGillis, W. A., Chicago, Ill.
McGinn, John W., Cheboygan, Mich.
McMahon & Montgomery Co., Chicago, Ill.
McSprit, James, Jersey City, N. J.
Meggett, Lockwood, Houston, Tex.
Metropolitan Dredging Co., Lynn, Mass
Mitchell & Co., Ludington, Mich.
Monroe & Richardson, Portsmouth, O.
Moore & Wright, Portland, Me.
Morgan, Thomas P., Washington, D. C.
Morris & Cumming Dredge Co., New York, N. Y.
Mower, Martin V. B., Lynn, Mass.
Mundy & Co., Philadelphia, Pa.
Myers, P. W., Albany, N. Y.
National Dredging Co., Wilmington, Del.
Neely & Smith, Chattanooga, Tenn.
Oliver, Henry, Charleston, S. C.
Osner, Wm., Chicago, Ill.
Packard, R G., New York, N. Y.
Parrott, Richard, Newburg, N. Y.
Payn, Edgar M., Albany, N. Y.

Pennsylvania Dredging Co., Philadelphia, Pa.
Potter, Thomas, New York, N. Y.
Racine Dredge Co., Racine, Wis.
Randerson, John P., Albany, N. Y.
Rittenhouse Moore Dredging Co., Mobile, Ala.
Rooney, James, Toledo, O.
Ross, P. Sanford, Jersey City, N. J.
Ross, R. G., Jacksonville, Fla.
San Francisco Bridge Co., New York, N. Y.
Satterlee, John, New York, N. Y.
Savannah Dredging Co., Savannah, Ga.
Scofield, Geo., Olympia, Wash.
Sears, David, Rock Island, Ill.
Seward, E. R., Albany, N. Y.
Sheboygan Dredge and Dock Co., Sheboygan, Wis.
Simpson, Geo. J., Philadelphia, Pa.
Smith, Alonzo E., Islip, New York.
Smith, H. M. C., Savannah, Ga.
Smith, Travis L., Columbia, Tex.
Somers, Frank C., Camden, N. J.
Somers, Fred. L., Philadelphia, Pa.
Souther, Chas., Boston, Mass.
Stang, John, Lorain, O.
Starke, Chris. H., Milwaukee, Wis.
Stone, Andrew K., Boston, Mass.
Symonds, Thomas, Leominster, Mass.
Taylor, Wm. H., Jersey City, N. J.
Vaughan, James T., Richmond, Va.
Von Schmidt & McNee, San Francisco, Cal.
W. H. Beard Dredging Co., New York, N. Y.
White & Finch, Grand Haven, Mich.
Whitney, Luther, Keeseville, N. Y.
Williams, Daugherty & Upham, Duluth, Minn.
Wisconsin Dredge and Dock Co., Manitowoc, Wis.
Wright, Augustus R., Portland, Me.
Young, Thomas, Charleston, S. C.

ROCK REMOVAL.

American Dredging Co., Philadelphia, Pa.
Andrews, Solon S., Gorham, Me.
Atlas Dredging Co., Wilmington, Del.
Bay City Dredging Co., Bay City, Mich.
Bowers Dredging Co.,Portland, Ore.
Brown, H. S., Quincy, Ill.
Burgwyn, C. P. E., Richmond, Va.
Burress, Ethan A., New Orleans, La.
Carberry, John C., Philadelphia, Pa.
Carkin, Stickney & Cram, Saginaw, Mich.
Cary, J. H., Memphis, Tenn.
Conlin & Garner, Thorold, Ontario, Can.
Curtis, John A., Richmond, Va.
Dixon, S. O., Racine, Wis.
Frazer, Simon C., New London, Conn.
Green's Dredging Co , Chicago, Ill.
Howard, Henry, Port Huron, Mich.
Johnson & Townsend, Somers Point, N. J.
Langhorne, C. D., Richmond, Va.
Lockerbie, George, Detroit, Mich.
Lovering, Edgar P., Boston, Mass.
Mason, Hoge & Dunn, Frankfort, Ky.
Masterton, Branch T., Galveston, Tex.
McCauley, Wm. F., Savannah, Ga.
McConville, D., Washington, D. C.
McDuff, W. A., Jacksonville, Fla.
Morgan, T. P., Washington, D. C.
National Dredging Co., Wilmington, Del.
Oliver, Henry, Charleston, S. C.
Phillips, Hiram W., Quincy Point, Mass.
Rittenhouse-Moore Dredging Co., Mobile, Ala.
Ross, P. Sanford, Jersey City, N. J.
San Francisco Bridge Co., San Francisco, Cal.
Sargent, Horace M., Portland, Me.
Satterlee, John, New York, N. Y.
Simpson, Geo. S., Philadelphia, Pa.
Somers, Frank C., Camden, N. J.
Sturgis, Herbert H., Bonny Eagle, Me.
Symonds, Thomas, Wilmington, Del.
Taylor, Wm. H., Jersey City, N. J.
Townsend & Olsen, Boston, Mass.
Townsend, Enoch, Somers Point, N. J.
Vaughan, James T., Richmond, Va.
Williams, Daugherty & Upham, Duluth, Minn.

REMOVING SUNKEN VESSELS.

Atlantic & Gulf Wrecking Co., Somers Point, N. J.
Bailey, B. G., Philadelphia, Pa.
Bearse, F. F., Chatham, Mass.
Bearse, Stephen F., Chatham, Mass.
Burgwyn, C. P. E., Richmond, Va.
Chapman Derrick and Wrecking Co., New York, N. Y.
Crouch, Haswell W., Charleston, S. C.
Davis Coast Wrecking Corporation, New Bedford, Mass.
Egan, Geo. W., Charleston, S. C.
French, W. H., Norfolk, Va.
Friday, Jacob, Pittsburgh, Pa.
Gill, T. H., Chatham, Mass.
Grant, Colin McK., Charleston, S. C.
Harper, James T., Wilmington, N. C.
Johnston & Townsend, Lewes, Del.
Johnston & Townsend, Somers Point, N. J.
Johnston, Chas. W., Lewes, Del.
Johnston, D. A., Camden, N. J.
Kelly, Cornelius J., Atlantic City, N. J.
Merritt Wrecking Organization, Norfolk, Va.
Myers, P. W., Albany, N. Y.
Nickerson & Kendrick, Chatham, Mass.
Nickerson, James E., Boston, Mass.
Pike, Wm. H., Brunswick Co., N. C.
Randerson, J. P., Albany, N. Y.
Ross, P. Sanford, Jersey City, N. J.
Smith, John G., Charleston, S. C.
St. John & Freer, Port Clinton, O.
Townsend, Enoch, Somers Point, N. J.
Truxton, Joseph D., Lewes, Del.
Van Sant, Gilbert S., Atlantic City, N. J.

JETTIES, DIKES, ETC.—SEA.

Alabama Dredging and Jetty Co., Montgomery, Ala.
Atlantic Contracting Co., New York, N. Y.
American Dredging Co., Philadelphia, Pa.
Andrews, Geo. Willett, Biddeford, Me.
Andrews, Solan S., Gorham, Me.
Applegate, Marion, Charleston, S. C.
Beattie, John, Leete's Island, Conn.
Blagen, N. J., Portland, Ore.
Bochman, Chas. G., Charleston, S. C.
Bouker, John A., New York, N. Y.
Branagan, Mat., Seattle, Wash.
Brandywine Granite Co., Wilmington, Del.
Brown & Fleming, New York, N. Y.
Bull, John C., Jr., Arcata, Cal.
California Bridge and Construction Co., San Francisco, Cal.
Campbell & McDonald, Duluth, Minn.
Chas. Clark & Co., Galveston, Tex.
Clarke, David D., South Bend, Wash.
Cleaves, Aaron, Chebeague, Me.
Colwell, Geo. L., Skamokawa, Wash.
Crouch, Haswell W., Charleston, S. C.
Curiat, Joseph W., Chebeague, Me.
Dickenson & Co., Tacoma, Wash.
Egan, Geo. W., Charlestown, S. C.
Elliott, Wm., Marysville, Cal.

Ely, Chas. C., Savannah, Ga.
Frazier, J. B., Grand Isle, Cal.
Friday, Jacob, Pittsburg, Pa.
Gaynor, Ed. H., New York, N. Y.
Gaynor, Wm. T., Fayetteville, N. Y.
Grant, Colin McK., Charleston, S. C.
Gray, Geo. W., Washington, D. C.
Hamilton, John F., Portland, Me.
Hondlette, Seth D., South Dresden, Me.
Hooper, C. A., San Francisco, Cal.
Howard, John E., Killgaver, Ore.
Howell, David V., New York, N, Y.
Hurley, Wm. P., Rockland, Me.
Hyatt, Frank A., Beaumont, Tex.
J. F. & J. N. Day, San Francisco, Cal.
Jordon & Carlton, Bath, Me.
Kern, Daniel, Portland, Ore.
King, Chas., Tacoma, Wash.
Kruse, Herman, San Francisco, Cal.
Levy, Gustav G., Galveston. Tex.
Luce, James V., East Lynn, Conn.
McCauley, W. F., Savannah, Ga.
McKay, John H., San Francisco, Cal.
McNaughton & Bapst, Buffalo, N. Y.
Moran, James J., Brooklyn, N. Y.
Mundy, Wm. A., Philadelphia, Pa.
National Dredging Co., Wilmington, Del.
Neeld, A. D., Washington, D. C.
Neelon, Geo. Mortimer, Green's Landing, Me.
Newel, Geo., Richmond, Me.
Oliver, Henry, Charleston, S. C.
Pacific Coast Contracting Co., Eureka, Cal.
Perkins & White, Boston, Mass.
Polson, Alex., Hoquiam, Wash.
Rittenhouse Moore Dredging Co., Mobile, Ala.
Ross, P. Sanford, Jersey City, N. J.
R. G. Ross & Co., Jacksonville, Fla.
Rowl, J. A., Boston, Mass.
S. &. E. S. Belden, Hartford, Conn.
Scully, James, Groton, Conn.
Skinner & Wallace, Wilmington, N. C.
Smith, Francis H., New York, N. Y.
Smith, J. E., Portland, Ore.
Smith, Travis L., Columbia, Tex.
Stewart Stone Co., Columbia, S. C.
Toomey, Humphrey, Guildford, Conn.
Verden, Wm. H., Lewis, Del.
Voorhis, John, Greenwich, Conn.
Wads, Chas. F., Richmond, Me.
Walsh, Wm. H., Charleston, S. C.
Warren, C. H., San Francisco, Cal.
White, Wm. S., Rockland, Me.

PIERS, DIKES, AND SHORE PROTECTION—RIVERS.

Alabama Dredging and Jetty Co., Mobile, Ala.
American Dredging Co., Philadelphia, Pa.
Applegate, Marion, Haysville, Pa.
Atlantic Contracting Co., New York, N. Y.
Babcock, C. F., Detroit, Mich.
Bradley, James F., Manchester, Va.
Brainard, Elijah, Jersey City, N. J.
Brown, H. S., Quincy, Ill.
Bryan, James A., River View, Fla.
Bull, John C., Jr., Arcata, Cal.
Burgwyn, C. P. E., Richmond, Va.
California Construction Co., San Francisco, Cal.
Campbell & McDonald, Duluth, Minn.
Candler Brothers, Detroit, Mich.
Carroll, Wm. E., Buffalo, N. Y.
Churchyard, Joseph J., Buffalo, N. Y.
Cleveland, Judson A., Duluth, Minn.
Conant, Marcus, Mayport, Fla.; New York, N. Y.
Culpepper, H. E., Portsmouth, Va.
Curtis, John A., Richmond, Va.
Davis, Wm. E., Duluth, Minn.
Dean & Touhey, Sacramento, Cal.
Donnelly Brothers, Buffalo, N. Y.
Douglass, James M., Baltimore, Md.
Dupuis, Augustus J., Detroit, Mich.
Edwards, Howlett & Thompson, New York, N. Y.
Elliott, Wm., Marysville, Cal.
Farnsworth, Ira, Lockport, N. Y.
Ferguson, Peter P., Ashland, Wis.
Fleury, Edgar S., Isle La Motte, Vt.
Frazier, J. B., Grand Isle, Cal.
Fruin Bambrich Construction Co., St. Louis, Mo.
Gaynor, E. H., New York, N. Y.
Goodsell, E. R., Plattsburg, N. Y.
Grant, Colin McK., Charleston, S. C.
Grim, C. P., Philadelphia, Pa.
Hankins, Mark O., Rio Vista, Va.
Howard, John E., Killgaver, Ore.
Hughes Bros. & Co., Syracuse, N. Y.
I. H. Hathaway & Co., New York, N. Y.
International Contracting Co., New York, N. Y.
James & Geyer, Chelsea, Mass.
Janney, T. G., Rio Vista, Va.
Kelly, Frederick J., New York, N. Y.
Kirchner, Albert, Fountain City, Wis.
Kirk, William, Madison, Ind.
Langhorne, C. D., Richmond, Va.
Laydon, Darby, San Francisco, Cal.
Mason, Hoge & Dunn, Frankfort, Ky.
McCarten, Hugh, Memphis, Tenn.
McCaulay, W. F., Savannah, Ga.
McDuff, W. A., Jacksonville, Fla.
McMahon, James A., San Francisco, Cal.
McNaughton & Bapst, Buffalo, N. Y.
Pacific Coast Contracting Co., Eureka, Cal.
Parrott, Wm., Albany, N. Y.
Patterson Bros., Keokuk, Iowa.
Platt, Geo. C., Philadelphia, Pa.
Richman, Jacob, Fountain City, Wis.
Ross, P. Sanford, Jersey City, N. J.
Ross, R. G., Jacksonville, Fla.
Ruark, Wm. H., West Pt., Va.
S. & E. S. Belden, Hartford, Conn.
Sanford & Brooks, Baltimore, Md.
San Francisco Bridge Co., San Francisco, Cal.
Savannah Dredging Co., Savannah, Ga.
Simpson, James, Eureka, Cal.
Starling & Smith Co., Greenville, Miss.
Steele, Hugh, Duluth, Minn.
Steiner, Michael, Detroit, Mich.
Talley, Ben., Memphis, Tenn.
Thompson & Gray, St. Charles, Mo.
Throckmorton, Jesse P,, Richmond, Va.
Todhunter, W. P., Sacramento, Cal.
Truax, Sidney J., Hastings, Minn.
Twiggs, Albert J., Augusta, Ga.
Voorhis, John, Greenwich, Conn.
Walsh, Wm. H., Fernandina, Fla.
Whitney, A. J., Rock Island, Ill.
Whitney, Luther, Keeseville, N. Y.
Wilkinson, Edwin, West Point, Va.
William Fuller & Son, New York, N. Y.
Williams, Chas. F., Rockland, Me.
Wisconsin Dredging and Dock Co., Manitowoc, Wis.
Whyte, Wm. C., New York, N. Y.
Young, Thomas, Charleston, S. C.
Zabriskie, Chas. B., Tacoma, Wash.

LEVEES AND EARTH WORKS.

Aderholdt, T. S., Friars Point, Miss.
American Dredging Co., Philadelphia, Pa.
Andrew Bros. Construction Co., Baton Rouge, La.
Applegate, Marion, Charleston. S. C.

Batchelor. I. G., Smithland, La.
Beith, R. H., Beith's Landing, Ark.
Bobbitt, I. R., Baton Rouge, La.
Bochman, Chas. G., Charleston, S. C.
Bogue, T. J., Beulah, Miss.
Brennan, James A., New Orleans, La.
Brock, F. A., Galveston, Tex.
Bull, John C., Jr., Arcata, Cal.
Burgwyn, C. P. E., Richmond, Va.
Byrne, James, Baton Rouge, La.
California Construction Co., San Francisco, Cal.
Carter, A. B., Memphis, Tenn.
Cary, James H., Memphis, Tenn.
C. D. Leeper & Co., Baton Rouge, La.
Cleary, John, Carrollton, La.
Coffman, P. J., Burnside P. O., La.
Colquitt, Robert K., Shreveport, La.
Condon, Dan, South Omaha, Neb.
Conner & Lester, Benoit, Miss.
Cotton, James, Raccourci, La.
Curtis, John A., Richmond, Va.
De Garis & Arnold, Memphis, Tenn.
De Garis, C. F., Memphis, Tenn.
Dennis, Thomas C., Jesuit's Bend, La.
Dickinson & Co., Tacoma, Wash.
Donovan, Daley & Co., St. Gabriel, La.
Doran, John, Missionary, La.
Elbringham, Alexander, Natchez, Miss.
Eldridge, John W., Hillhouse, Miss.
Elliott, Wm., Marysville, Cal.
Epply & Martin, Bolivia, Miss.
Ferguson, Th. C., Glendale, Miss.
Fleming, James S., Natchez, Miss.
Fort, Sterling, Greenville, Miss.
Frazier, J. B., Grand Isle, Cal.
Friedler, Ignatz, Vidalia, La.
Fruin Bambrich Construction Co., St. Louis, Mo.
Fullilove, James H., Shreveport, La.
Grant, Colin McKay, Charleston, S. C.
Green Clay & Son, Mexico, Mo.
Green, Rogers & Co., New Orleans, La.
Greer, John R., Memphis, Tenn.
Grigsby. Geo. M. D., Jefferson, Tex.
Hannan, McFadden & Cassidy, Baton Rouge, La.
Hanlon & Dowdell, Legonier, La.
Harnan, P., New Orleans, La.
Hartnett, O'Brien, Donovan & Dailey, Memphis, Tenn.
Harvey & McGuire, Greenville, Miss.
Hayes & Hayes, Welchton, La.
Henry, Isaac, Millikens Bend, La.
Henry, Manoah V., Birmingham, Ala.
Hewey, M. N., Birmingham Ala.
Hodge, J. C., Memphis, Tenn.
Hogan & Robertson, Cairo, Ill.
Huber, Oskar, Spokane, Wash.
Hunt, Michael, Missionary, La.
Hyner, Earnest, Greenville, Miss.
Irish, N. Wm., Carlyle, Ill.
J. A. Carson & Co., Baton Rouge, La.
James, Samuel L., Jr., Baton Rouge, La.
Janney, T. G., Rio Vista, Va.
Jefferies & Dameron, Memphis, Tenn.
Jennings & Co., Memphis, Tenn.
J. G. & I. N. Day, Portland, Ore.
John Scott & Son, St. Louis, Mo.
Jones, Chas. S., New Orleans, La.
J. S. Tighe & Co., Memphis, Tenn.
Kane, Michael, Baton Rouge, La.
Killeen, John, New Liberty, Iowa.
Kilpatrick & Storer, Collins, La.
King & Nelson, Des Moines, Iowa.
Lacour, Ovide, Raccourci, La.
Lamb, P. F., Memphis, Tenn.
Landin, Samuel H., Jr., Natchez, La.
Leche, Edward D., Island P.O., La.
Lewis, James B., Luna, Ark.
Louque, John E., Carrollton, La.
Lynch, John D., Monmouth, Ill.
Manning & Gibson, Natchez, Miss.
Mantell, E. B., Memphis, Tenn.
Martin, Augustus P., Waterproof, La.
Martin, R. T., Bolivia, Miss.
Martin, Thomas J., Missionary, La.
Mason, Hoge & Dunn, Frankfort, Ky.
McDonald, A., Memphis, Tenn.
McLaughlin Brothers, Memphis, Tenn.
McMahon, James A., San Francisco, Cal.
McNamara, Robert, New Orleans, La.
Meredith & Speers, Memphis, Tenn.
Monroe & Richardson, Portsmouth, Ohio.
Morgan, Hugh, Memphis, Tenn.
Ogden, James N., Baton Rouge, La.
O'Hearn, James E., Wilmington, N. C.
O'Malley, Thomas, Baton Rouge, La.
Patterson Brothers, Keokuk, Iowa.
Phillips, James, P. M., San Francisco, Cal.
Phillips, Nat. P., Red River Landing, La.
Quinn, John J., Merricks, La.
Reilly, Peter J., New Orleans, La.
Reilly, Richard, Chicago, Ill.
Ross. P. Sanford, Jersey City, N. J.
Rosser, Thomas L., Charlotteville, Va.
Rutherford & Dalgarn, Natchez, Miss.
Scott & Russell, Memphis, Tenn.
S. D. Moody & Co., New Orleans, La.
Sears, David, Rock Island, Ill.
Shelton, Edwin R., Memphis, Tenn.
Shippey, Wm. A., Memphis, Tenn.
Smith, John G., Charleston, S. C.
Sneed & Blue, Memphis, Tenn.
Stewart Stone Co., Columbia, S. C.
Sullivan, Johnston & McLaughlin, Memphis, Tenn.
Sullivan, Timothy, Memphis, Tenn.
Talley, Ben., Memphis, Tenn.
Turcan, H. B., Jesuit's Bend, La.
Vance & Franklin, Garvey, Ark.
Vance, Robert, Memphis, Tenn.
Vincent & Mahony, San Francisco, Cal.
W. F. Barbour & Co., Lucy P.O., La.
White, Edmond P., New Orleans, La.
Winter, Charles A., Greenville, Miss.
W. J. Bentley & Co., Green Store, La.
W. L. Withers & Co., Gladstone, Miss.
W. O. Flynn & Co., Baton Rouge, La.
Worthington, Charles T., Leota, Miss.
Young, Thomas, Charleston, S. C.

PIERS, DIKES, ETC.—LAKES.

A. C. & E. W. Raymond, Omaha, Neb.
Allmendinger, John M., Benton Harbor, Mich.
Babcock, Chas. F., Detroit, Mich.
Barker, Chas. S., West Superior, Mich.
Berner, Charles, Green Bay, Wis.
Borgman, J. M. Kewaunee, Wis.
Breyman Brothers, Toledo, Ohio.
Brown, Henry S., Quincy, Ill.
Campbell & McDonald, Duluth, Minn.
Candler Brothers, Detroit, Mich.
Chandler, F. S., Toledo, Ohio.
Conlon & Garner, Thorold, Ontario, Can.
Cook, Wallace P., Oconto, Wis.
Crosby, Edward G., Muskegon, Mich.
Culbert & Lutz, Michigan City, Ind.
Cushing, Richard C., Omaha, Neb.
Daly, William J., Ogdensburg, N. Y.
Donnelly, James B., Buffalo, N. Y.
Drew, F. C., Chicago, Ill.
Dunbar & Sullivan, Buffalo, N. Y.

Dupuis, Augustus, Detroit, Mich.
Ferguson, A. R., Manistee, Mich.
Galloway, Peter W., Racine, Wis.
Gaylord & Wing, Ludington, Mich.
Gilmore, Quincy, Lorain, Ohio.
Green Bay Dredging and Pile-Driver Co., Green Bay, Wis.
Green Dredging Co., Chicago, Ill.
Gustin, Henry K., Ann Arbor, Mich.
Hathaway, John A., Milwaukee, Wis.
Heidenreich Co., Chicago, Ill.
Hiero B. Herr & Co., Chicago, Ill.
Howard, Henry, Port Huron, Mich.
Kimball & Cobb Stone Co., Chicago, Ill.
Kirchner, Albert, Fountain City, Wis.
Kirk, William, Madison, Ind.
Knapp & Gillen, Racine, Wis.
Lantz, August, Milwaukee, Wis.; Green Bay, Wis.
Lockerbie, George, Detroit, Mich.
L. P. & J. A. Smith, Cleveland, Ohio.
Lydon, Wm. A., Chicago, Ill.
Lynch, John D., Monmouth, Ill.
Mallory, Smith H., Chariton, Iowa.
Mason, Hoge & Dunn, Frankfort, Ky.
McDonald, Francis L., Duluth, Minn.
McLeod, D. A., Manistee, Mich.
McMahon, James A., San Francisco, Cal.
Mitchell, Edward, Marquette, Mich.
Mitchell, John, Marquette, Mich.
Mitchell, John A., Ludington, Mich.
Moore, Smith, Marquette, Mich.
Nicholson, Peter, Duluth, Minn.
Powell, Daniel W., Marquette, Mich.
Quinby & Omeis, Duluth, Minn.
Rieboldt & Wolter, Sheboygan, Wis.
Rielly, Richard, Chicago, Ill.
Rooney, James, Toledo, Ohio.
Sadler & Allen, Detroit, Mich.
San Francisco Bridge Co., San Francisco, Cal.
Sang, David, Duluth, Minn.
Sawyer, Wm. E., Manistee, Mich.
Stang, John, Lorain, Ohio.
Steele, Hugh, Duluth, Minn.
Taylor, Geo., Duluth, Minn.
Truax, Sidney J., Hastings, Minn.
Weimer & Rath, Manistee, Mich.
Whitney, A. J., Rock Island, Ill.
White & Finch, Grand Haven, Mich.
Williams, Daugherty & Upham, Duluth, Minn.
Wisconsin Dredge and Dock Co., Manitowoc, Wis.
Wrabetz, John, Kewaunee, Wis.

STONE SUPPLIES.

Ahern, Michael, Hastings, Minn.
Alley, James W., Memphis, Tenn.
Amberg Granite Co., Chicago, Ill.
Andrews, Geo. Willett, Biddeford, Me.
Andrews, Solon S., Gorham, Me.
Becker, Henry, Dresback, Minn.
Becker, Perry, Pontoosuc, Ill.
Birmingham Mining and Mfg. Co., Birmingham, Ala.
Blagen, N. J., Portland, Oregon.
Booth Brothers, New York, N. Y.
Borthwick, Henry B., Portland, Ore.
Cabot, Fred. M., Gate City, Ala.
Cape Ann Granite Co., Boston, Mass.
Consolidated Quarry Co., Washington, D. C.
Curit, Joseph F., Chebeague, Me.
Day, James H., Portland, Orc.
D. M. Richardson & S. Monroe, Portsmouth, Ohio.
Edinger, Edward, Davenport, Iowa.
G. & M. Gasaway, Dallas City, Ill.
Geo. G. Smith & Son, Washington, D. C.
Graham, John T., Dallas City, Ill.
Gray, Geo. W., Georgetown, D. C.
Guildford and Waterville Granite Co., Baltimore, Md.
Gunning Gravel and Paving Co., Vicksburg, Miss.
Hallowell Granite Works, Hallowell, Me.
Hely, Edward, West Plains, Mo.
Henry & Co., Birmingham, Ala.
Hinkle, Perry, Portland, Ore.
Hoyt, Richard, Portland, Ore.
Huckstein Stone Co., Allegheny, Pa.
Hurricane Isle Granite Co., New York, N. Y
I. Hathaway & Co., Philadelphia, Pa.
Jacobson, Wm., Portland, Ore.
Kirchner, Albert, Fountain City, Wis.
Kern, Daniel, Portland, Ore.
Killebrew, Wm. L., Greenville, Miss.
Killeen, John, New Liberty, Iowa.
Kimball & Cobb Stone Co., Chicago, Ill.
Lanesville Granite Co., Rockport, Me.
Leach, Edgar R., Richmond, Minn.
Luce, James V., Nantic, Conn.
Mathes, Christian, Burlington, Iowa.
Maxwell, Wm. Henry, Spokane, Wash.
McCarthy, Justin, Washington, D. C.
McConville, Daniel, Washington, D. C.
Minnesota Stone Co., Minneapolis, Minn.
Mohler, Wm. Henry, Washington, D. C.
Mt. Waldo Granite Works, Frankfort, Me.
Neeld, Almos D., Washington, D. C.
New England Granite Works, Hartford, Conn.
Norcross Brothers, Worcester, Mass.
North Carolina Brown Stone Co., Sanford, N. C.
North River Blue Stone Works, New York, N. Y.
O'Neil, Patrick, San Francisco, Cal.
Rockport & Pigeon Hill Granite Co., Rockport, Me.
Scully, James, Groton, Conn.
Simpson, Geo. J., Philadelphia, Pa.
Sjogren, Charles, Hastings, Minn.
Slumter, Clayton B., Chester, Pa.
Smith, Frances H., New York, N. Y.
Smith, James E., Portland, Ore.
Stewart Stone Co., Columbia, S. C.
Thompson & Gray, St. Charles, Mo.,
Truax, F. N., St. Paul Park, Minn.
Velie & Nason, Moline, Ill.
Vermont Marble Co., Proctor, Vt.
Watson, Bliss & Co., Hartford, Conn.
W. E. Speer & Co., Washington, D. C.
Westenhavir & Co., Martinsburg, W. Va.
White, Joseph H., Boston, Mass.
White, Wm. S., Rockland, Me.
Woodward, Wight & Co., New Orleans, La.
Worthington & Co., Birmingham, Ala.

TIMBER, BRUSHWOOD, ETC.

Ahern, Michael, Hastings, Minn.
Allen. Luther E., Detroit, Mich.
Ames, Herbert, St. Paul Park, Minn.
Brown, Henry S., Quincy, Ill.
Diver & Swanwick, Keokuk, Iowa.
D. M. Clarkson Lumber Co., Portland, Ore.
Ferguson, A. R., Manistee, Mich.
Foster & Hastings, Tacoma, Wash.
Fremont Milling Co., Seattle, Wash.
Gasaway Brothers, Dallas City, Ill.
Gelatt, Walter B., Columbus Junction, Iowa.
Graham, John T., Dallas City, Ill.
Gustin, Henry K., Ann Arbor, Mich.
Hamlin, E. D., Tacoma, Wash.
Hogue, Henry A., Portland, Ore.
Hunter & Frey, Memphis, Tenn.
Killeen, John, New Liberty, Iowa.
Long, George M., Delta, La.
Lutes, R. P., St. Louis, Mo.

McDonald, C. Irwin, Pittsburg, Pa.
Nagel, Tobias, New Orleans, La.
North Pacific Lumber Co., Portland, Ore.
Parson & Robinson, Whitehall, Mich.
Pence, Phillip, Lomax, Ill.
Reagan, Geo. W., Red River Landing, La.
Richardson & Monroe, Portsmouth, Ohio.
Schmoker, Jacob, Fountain City, Wis.
Seatco Mfg. Co., Chicago, Ill.
Shain Wm. A., Pontoosuc, Ill.
Shane, Edward D., Hastings, Minn.
St. Louis Refrigerator Co., St. Louis, Mo.
Tacoma Mill Co., Tacoma, Wash.
Thompson & Gray, St. Charles, Mo.
Truax, Frank M., St. Paul Park, Minn.
Truax, Sidney J., Hastings, Minn.
Van Sant, R. L., St. Louis, Mo.
Weimer, Emery D., Ludington, Mich.
White, Robert M., New Orleans, La.
Winters, Charles P., Fort Madison, Iowa.
Woodward, Wight & Co., New Orleans, La.

OTHER SUPPLIES.

Anchor Line Store, St. Louis, Mo.
Condon, Dan., South Omaha, Neb.
Gray, Geo. W., Georgetown, D. C.
Hawk, James J., St. Louis, Mo.
James Ward & Son, St. Louis, Mo.
Killeen, John, New Liberty, Iowa.
King & Nelson, Des Moines, Iowa.
Lynch, John D., Monmouth, Ill.
Maxwell, Thomas G., St. Louis, Mo.
M. M. Buck & Co., St. Louis, Mo.
Monroe & Richardson, Portsmouth, Ohio.
Neeld, Almos D., Washington, D. C.
S. C. Forsaith Machine Co., Manchester, N. H.
Sears, Daniel, Rock Island, Ill.
Simpson, Geo. J., Philadelphia, Pa.
St. Louis Wire Mill Co., St. Louis, Mo.

PILE DRIVING.

Allison, Wm. G., Chester, Ill.
American Dredging Co., Philadelphia, Pa.
Applegate, Marion, Charleston, S. C.
Atlantic Contracting Co., New York, N. Y.
Babcock, Charles F., Detroit, Mich.
Bradley, James F., Manchester, Vt.
Brown, H. S., Quincy, Ill.
Burgwyn, C. P. E., Richmond, Va.
Cleary, John, Chester, Ill.
Curtis, John A., Richmond, Va.
Davis & Erwin, Philadelphia, Pa.
Du Bois, Charles, New York, N. Y.
Elliott, Wm., Sr., Cridley, Cal.
Fraser, Simon C., New London, Conn.
Gelatt, Wm. B., Columbus Junction, Iowa.
Gilbreath, Whitney, Ava, Ill.
Grant, Colin McK., Charleston, S. C.
Green Bay Pile-Driver Co., Green Bay, Wis.
Hartnett & O'Brien, Memphis, Tenn.
International Contracting Co., New York, N. Y.
Langhorne, Chas. D., Richmond, Va.
Martin, Augustus P., Waterproof, La.
Mason, Hoge & Dunn, Frankfort, Ky.
McDonald, C. Whitney, Pittsburg, Pa.
McMahon & Montgomery Co., Chicago, Ill.
Ogden, James N., Baton Rouge, La.
Oliver, Sebastian, Chester, Ill.
O'Malley, Thomas, Baton Rouge, La.
Randerson, John P., Albany, N. Y.
R. L. Van Sant & Co., St. Louis, Mo.
Ross, P. Sanford, Jersey City, N. J.
San Francisco Bridge Co., New York, N. Y.
S. D. Moody & Co., New Orleans, La.
Sheboygan Dock Co., Sheboygan, Wis.
Souther, Charles, Boston, Mass.
Taylor, Geo., Duluth, Minn.
Thompson & Grey, St. Louis, Mo.
Throckmorton, Jesse P., Richmond, Va.
Twiggs, Albert J., Augusta, Ga.
Von Schmidt & McNee, San Francisco, Cal.
Wisconsin Dock Co., Manitowoc, Wis.

SNAG AND TREE REMOVAL.

Alabama Dredging and Jetty Co., Mobile, Ala.
Applegate, Marion, Haysville, Pa.
Atlantic Contracting Co., New York, N. Y.
Babcock, C. F., Detroit, Mich.
Brainard, Elijah, Jersey City, N. J.
Bryan, James A., River View, Fla.
Bull, John C., Jr., Arcata, Cal.
Candler Bros., Detroit, Mich.
Dean & Touhey, Sacramento, Cal.
Dupuis, Augustus J., Detroit, Mich.
Elliott, Wm., Sr., Cridley, Cal.
Grant, Colin McK., Charleston, S. C.
I. H. Hathaway & Co., New York, N. Y.
International Contracting Co., New York, N. Y.
Laydon, Darby, San Francisco, Cal.
McDuff, Wm. A., Jacksonville, Fla.
McMahon, J. A., San Francisco, Cal.
Ross, P. Sanford, Jersey City, N. J.
Ross, R. G., Jacksonville, Fla.
San Francisco Bridge Co., San Francisco, Cal.
Savannah Dredging Co., Savannah, Ga.
Simpson, James, Eureka, Cal.
Steiner, Michael, Detroit, Mich.
Tibbetts, Robert, San Francisco, Cal.
Todhunter, W. P., Sacramento, Cal.
Twiggs, Albert J., Augusta, Ga.
Walsh, Wm. H., Fernandina, Fla.

LOCKS AND DAMS.

Caldwell, Geo. L., Skamokawa, Wash.
Christie & Lowe, Washington, D. C.
Clark, Tere A., Quincy, Ill.
Condon, Dan, South Omaha, Neb.
Davidson & Borthwick, Portland, Ore.
Erickson & Co., Portland, Ore.
Henry, M. V., Birmingham, Ala.
Hinkle, Perry, Portland, Ore.
Hoffman & Bates, Portland, Ore.
Holmes & Wilk, Nashville, Tenn.
Holmes, Henry F., Nashville, Tenn.
H. M. Montgomery & Co., Portland, Ore.
Jacobson, Wm., Portland, Ore.
Janney, T. G., Rio Vista, Va.
Kern, Daniel, Portland, Ore.
Killeen, John, New Liberty, Iowa.
King & Nelson, Des Moines, Iowa.
Kirk & Miller, Madison, Ind.
Lalande & Co., Birmingham, Ala.
Lynch, John D., Monmouth, Ill.
McMahon, James A., San Francisco, Cal.
Monroe & Richardson, Portsmouth, Ohio.
Neely & Smith, Chattanooga, Tenn.
Nelles, Geo. T., Leavenworth, Kan.
Paquet & Smith, Portland, Ore.
Petididier & Hoag, Cincinnati, Ohio.
Reilly, Richard, Chicago, Ill.
Salem Bedford Store Co., Salem, Ind.
Sears, David, Rock Island, Ill.
Shanks, T. P., Louisville, Ky.
Smith, J. E., Portland, Ore.
Shipman & Stewart, Washington, D. C.
Walton & Co., Roanoke, Va.

MACHINERY AND IRON WORK.

Allen, Luther E., Detroit, Mich.
Allentown Rolling Mills, Allentown, Pa.
Allison, Wm. G., Chester, Ill.
Anchor Line Store, St. Louis, Mo.
Armourdale Foundry Co., Kansas City, Mo.
Barnes, Charles, Cincinnati, Ohio.
Bartlett, Hayward & Co., Baltimore, Md.
Bartlett, Robbins & Co., Baltimore, Md.
Benner & Opdyke, Philadelphia, Pa.
Bindell & Seifert, Chicago, Ill.
Brown-Ketcham Iron-Works, Indianapolis, Ind.
Builders' Iron Foundry, Providence, R. I.
Charles Sundberg & Co., Chicago, Ill.
Cincinnati Iron Works, Cincinnati, O.
Cleary, John, Chicago, Ill.
Clements Company, Cincinnati, O.
Colwell Iron Works, New York City.
C. Rittenhouse & Sons, Norristown, Pa.
Crown Iron Works, Minneapolis, Minn.
Dearborn Foundry Co., Chicago, Ill.
Detroit Locomotive Works, Detroit, Mich.
Dunkerley, James B., St. Louis, Mo.
Ferguson, A. R., Manistee, Mich.
F. J. Myers Mfg. Co., Covington, Ky.
Flaherty, Wm. H., New York, N. Y.
Fletcher, Jenks & Co., Detroit, Mich.
Francis Firtsch Foundry Co., Cincinnati, O.
Geo. Kenney & Co., Cincinnati, O.
Gillette-Herzog Mfg. Co., Minneapolis, Minn.
Gude & Walker, Atlanta, Ga.
Geo. W. & F. Smith Iron Co., Boston, Mass.
H. A. Ramsay & Co., Baltimore, Md.
Harrisburg Foundry and Machine Works, Harrisburg, Pa.
Hawk, James J., St. Louis, Mo.
Hoefinger & Lane Foundry Co., Cincinnati, O.
Holmes, Pyott & Co., Chicago, Ill.
Holmes & Wilk, Nashville, Tenn.
I. & E. Greenwall Co., Cincinnati, O.
Jackson Architectural Iron Works, New York, N. Y.
James Rees & Sons, Pittsburg, Pa.
James Ward & Son, St. Louis, Mo.
Kansas City Iron Works, Kansas City, Mo.
King Bridge Co., Cleveland, O.
Koken Iron Works, St. Louis, Mo.
Lambert Bros. & Co., Ironton, O.
L. Schneider & Sons Co., Cincinnati, O.
March, Wm. H., Philadelphia, Pa.
Marshall, Thomas, Pittsburg, Pa.
Maxwell, Thomas S., St. Louis, Mo.
Mayer, Fred., St. Louis, Mo.
McGuire, John P., Cleveland, O.
McLeod, D. A., Manistee, Mich.
Milwaukee Bridge Works, Milwaukee, Wis.
M. M. Buck & Co., St. Louis, Mo.
Morris, Tasker & Co., Philadelphia, Pa.
Maryland Steel Co., Sparrow's Point, Md.
New Jersey Steel and Iron Co., Trenton, N. J.
North Western Wheel and Foundry Co., St. Paul, Minn.
Parkhurst & Wilkinson, Chicago, Ill.
Patton, Hall & Patton, Marietta, O.
Paxton and Vierling Iron Works, Omaha, Neb.
Phœnix Iron Co., Phœnixville, Pa.
Poole & Son, Baltimore, Md.
Pusey & Jones Co., Wilmington, Del.
Reno, John W., New Madrid, Mo.
Rinker & Hoff, Minneapolis, Minn.
Richmond Iron Works, Richmond, Va.
Russell Wheel and Foundry Co., Detroit, Mich.
Ryan McDonald Mfg. Co., Baltimore, Md.
S. C. Forsaith Machine Co., Manchester, N. H.
Sentman, E. S., Philadelphia, Pa.
Shiffler Bridge Co., Pittsburg, Pa.
Snead & Co. Iron Works, Louisville, Ky.
Sooysmith & Co., New York, N. Y.
Southwark Foundry and Machine Co., Philadelphia, Pa.
St. Louis Wire Mill Co., St, Louis, Mo.
St. Paul Foundry Co., St. Paul, Minn,
Tacony Iron Co., Philadelphia, Pa.
The Portland Co., Portland, Me.
Union Foundry Works, Chicago, Ill,
Van Dorn Iron Works, Cleveland, O.
Vulcan Iron Works, Chicago, Ill.
Wagner, J. G., Milwaukee, Wis.
Walker Mfg. Co., Cleveland, O.
Weimar, Emery D., Ludington, Mich.
Weimer Iron Works, Lebanon, Pa.
West Point Foundry Co., Cold Spring, N. Y.
Wheeler Condenser and Engine Co., Carteret, N. J.
Wisconsin Bridge Co., Milwaukee, Wis.
Wm. Bagley & Sons Co., Milwaukee, Wis,

MASONRY CONSTRUCTION—LAND.

Brandywine Granite Co., Wilmington, Del.
C. T. Derry & Co., Boston, Mass.
Davis & Erwin, Philadelphia, Pa.
Grant, Colin McK., Charleston, S. C.
Harvey, S. G., Albany, N. Y.
Howell, David V., New York, N. Y.
Hughes Brothers & Bangs, Syracuse, N. Y.
I. H. Hathaway, Philadelphia, Pa.
J. H. Day & Co., Cincinnati, Ohio.
Johnston, Chas. N., Somers Point, N. J.
Luce, James V., Niantic, Conn.
Manhattan Supply Co., New York, N. Y.
Molthrop, Wm. H., Gales Ferry, Conn.
Rockport and Pigeon Hill Granite Co., Rockport, Me.
Rodgers, Hallen & Farrell, Cincinnati, Ohio.
Ryan McDonald Mfg. Co., Baltimore, Md.
S. C. Forsaith Machine Co., Manchester, N. H.
Scully, James, Groton, Conn.
Singgs, A. J., Augusta, Ga.
Smith, Francis H., New York, N. Y.
S. S. Leonard & Co., Buffalo, N. Y.
Starke, Benj., Jr., New London, Conn.
Steffner & Sloan, Chattanooga, Tenn.
Thomas Collin's Sons, Alleghany, Pa.
Toomey, Humphrey, Guildford, Conn.
Townsend, Enoch, Somers Point, N. J.
White, Joseph H., Boston, Mass.
Young, Thomas, Charleston, S. C.

TIMBER CONSTRUCTION—LAND.

Bochman, Charles G., Charleston, S. C.
Bradley, James F., Manchester, Va.
Burgwyn, C. P. E., Richmond, Va.
Culpepper, Henry E., Portsmouth, Va.
Curtis, John A., Richmond, Va.
Douglass, James M., Baltimore, Md.
Ferguson, Thomas C., Glendale, Miss.
Kirchner, Albert, Fountain City, Wis.
Langhorne, Chas. D., Richmond, Va.
Mason, Hoge & Dunn, Frankfort, Ky.
Ogden, James N., Baton Rouge, La.
Scott & Russell, Memphis, Tenn.
Throckmorton, Jesse P., Richmond, Va.
Truax, Sidney J., Hastings, Minn.
Twiggs, Albert J., Augusta, Ga.
W. J. Bentley & Co., Green's Store, La.
W. L. Withers & Co., Gladstone, Miss.

BRIDGES.

Berlin Iron Bridge Co., Windsor, Conn.
Boston Bridge Works, Boston, Mass.

Bullen Bridge Co., Pueblo, Col.
Groton Bridge Co., Groton, N. Y.
Iron Substructure Co., Columbus, O.
Jackson Architectural Iron Works, New York, N. Y.
Kansas City Iron Works, Kansas City, Mo.
King Bridge Co., Cleveland, O.
Louisville Bridge Co., Louisville, Ky.
Milwaukee Bridge Works, Milwaukee, Wis.
Nelson & Buchanan, Pittsburg, Pa.
New Jersey Steel and Iron Co., Trenton, N. J.
Pennsylvania Bridge Co., Beaver Falls, Pa.
Phœnix Iron Co., Phœnixville, Pa.
Richmond Iron Works, Richmond, Va.
Shailer Schniglau Co., Chicago, Ill.
Shiffler Bridge Co., Pittsburg, Pa.
Toledo Bridge Co., Toledo, O.
Wagner, J. W., Milwaukee, Wis.
Weimer Iron Works, Lebanon, Pa.
Wisconsin Bridge Co., Milwaukee, Wis.
Wrought Iron Bridge Co., Canton, Ohio.
Youngstown Bridge Co., Youngstown, Ohio.

BOATS, DREDGES.

Atlantic Contracting Co., New York, N. Y.
Bay City Dredging Co., Bay City, Mich.
Bowers Dredge Co., Portland, Ore.
Brown, H. S., Quincy, Ill.
Bucyrus Steam Shovel and Dredge Co., Bucyrus, O.
Carbolineum Wood Preserving and Mfg. Co., New Orleans, La.
Carkin, Stickney & Cramp, East Saginaw, Mich.
C. E. Mitchell & Co., Ludington, Mich.
Chicago Dredge Co., Chicago, Ill.
Clement Brothers, Paducah, Ky.
Edwards, Joseph, New York, N. Y.
Emerson, Luther M., St. Louis, Mo.
Flesher, S. M., Levanna, Ohio.
Fourchy & Fourchy, New Orleans, La.
Frisbie Engine and Machine Co., Cincinnati, Ohio.
Green Bay Dredge Co., Green Bay, Wis.
Hartford Dredge Co., Hartford, Conn.
Howard, Edward J., Jeffersonville, Ind.
Huntington and St. Louis Towboat Co., Cincinnati, Ohio.
Isherwood, Thomas G., Davenport, Iowa.
M. A. Sweeny & Bro., Jeffersonville, Ind.
Osgood Dredge Co., Albany, N. Y.
Pelican Saw Mill and Mfg. Co., New York, N. Y.
Samuel W. Coffin & Son, Cincinnati, Ohio.
San Francisco Bridge Co., New York, N. Y.
Skinner, Louis H., Wilmington, N. C.
Souther, Charles, Boston, Mass.
Telson, Christian, Sr., New Orleans, La.
Vaughan, James T., Richmond, Va.
W. H. Beard Dredge Co., New York, N. Y.
Wisconsin Dredge Co., Manitowoc, Mich.

BOATS—STEAM.

Barmore, David S., Madison, Ind.
Diamond Jo Line Steamers, South St. Louis, Mo.
Flesher, S. M., Levanna, Ohio.
Howard, Edward J. Jeffersonville, Ind.
L. Cramer & Son, Parkersburg, West Va.
Morse, Thomas P., South St. Louis, Mo.
Sims, James P., St. Louis, Mo.
T. H. Truscott & Sons, St. Joseph, Mo.
Weigel Brothers, Elizabeth, N. J.

BOATS—SCOWS.

Brown, H. S., Quincy, Ill.
Brusstar Shipbuilding Co., Baltimore, Md.
Bucyrus Steam Shovel and Dredge Co., Bucyrus, O.
Carkin, Stickney & Cram, East Saginaw, Mich.
C. E. Mitchell & Co., Ludington, Mich.
Donly, Geo. W., Richmond, Va.
Hanson, John, Berwick, La.
Hartford Dredging Co., Hartford, Conn.
Harvey & Erlanger, Harvey's Landing, La.
Hoagland, Lewis H., Portsmouth, Va.
James Clark Co., Baltimore, Md.
Giles & Allardyce, Burkeville, Tex.
McReynolds & Plummer, Sabine, Tex.
Morrison & Co., Petersburg, Va.
Nouvet, P. F., New Orleans, La.
Parrott, Wm., Albany, N. Y.
Reed, Wilson, Norfolk, Va.
Rooney, James, Toledo, Ohio.
San Francisco Bridge Co., San Francisco, Cal.
Shaw, Geo. D., Abbeville, La.
Skinner, Louis H., Wilmington, N. C.
Springer, Charles, New Orleans, La.
Von Schoeler, Victor, Frankfort, La.
Walsh, John F., Jr., New York, N. Y.
W. H. Beard Dredge Co., New York, N. Y.
Wm. E. Woodall & Co., Baltimore, Md.
Young, James, Cincinnati, Ohio.

LIGHT-HOUSES.

Allentown Rolling Mills, Allentown, Pa.
B. & J. Carpenter, Philadelphia, Pa.
Bartlett, Haywood & Co., Baltimore, Md.
Bartlett, Robbins & Co., Baltimore, Md.
Bollman, Wendell, Philadelphia, Pa.
Builders' Iron Foundry, Providence, R. I.
Chas. Sundberg & Co., Chicago, Ill.
Colwell Iron Works, New York, N. Y.
C. Rittenhouse & Son, Norristown, Pa.
Dearborn Foundry Co., Chicago, Ill.
Demmons, Forson & Co., Baltimore, Md.
Detroit Locomotive Works, Detroit, Mich.
Dunbar, Geo. H., Chicago Ill.
Flaherty, Wm. H., New York City, N. Y.
Garfield, A. H., Washington, D. C.
Gere, N. Stanton, Richmond, Va.
G. W. & F. Smith Iron Co., Boston, Mass.
H. A. Ramsay & Co., Baltimore, Md.
Harrisburg Foundry and Machine Works, Harrisburg, Pa.
Janes & Kirtland, New York, N. Y.
Jennings, C. F., Chicago, Ill.
Mollon & Rourke, New York, N. Y.
Maryland Steel Co., Sparrow's Point, Md.
McGuire, John P., Cleveland, Ohio.
Morris & Tasker, Philadelphia, Pa.
Paulding, Kemble & Co., New York, N. Y.
Paxton & Vierling Iron Works, Omaha, Neb.
Phœnix Iron Co., Trenton, N. J.
Poole & Son, Baltimore, Md.
Pusey & Jones Co., Wilmington, Del.
Richmond Iron Works, Richmond, Va.
Russell Wheel & Foundry Co., Detroit, Mich.
Scott & Co., New York, N. Y.
S. & E. G. Smyser & Co., Philadelphia, Pa.
Smith, F. H. & Co., New York, N. Y.
South Boston Iron Co., Boston, Mass.
Sooysmith & Co., New York, N. Y.
Streeter, Herbert A., New York, N. Y.
Tacomy Iron and Metal Co., Philadelphia, Pa.
The Portland Co., Portland, Me.
Union Foundry Works, Chicago, Ill.
Vulcan Iron Works, Chicago, Ill.
Walker Mfg. Co., Cleveland, Ohio.
Weimer Works, Lebanon, Pa.
West Point Foundry Co., Cold Spring, N. Y.
Wheeler Condenser and Engine Co., Carteret, N. J.

HOUSES—MASONRY.

Ackerman, Charles, Sheboygan, Wis.
A. H. Connor & Co., Cedar Rapids, Iowa.
Allen & Weiths, St. Louis, Mo.
Amberg Granite Co., Chicago, Ill.
Anderson Brothers, St. Louis, Mo.
A. S. Reed & Brothers, Wilmington, Del.
Baldwin, Frank, Washington, D. C.
Bassett, Nelson M., Austin, Ill.
Bassford, A., St. Paul, Minn.
Bassford, Asa, Philadelphia, Pa.
Bean, B. F., Sioux Falls, S. Dak.
Bentley, Th. R., Milwaukee, Wis.
Bourniuf, Augustine, Haverhill, Mass.
Brightman, Chas. O., New Bedford, Mass.
Brown & Buckley, New York, N. Y.
Brown & Dabney, Dallas, Texas.
Brown, J. M., Houston, Texas.
Campbell, James S., Fargo, S. Dak.
Carlisle, James, Minneapolis, Minn.
Carroll, J. F., St. Paul, Minn.
Carruthers, Samuel, Dallas, Texas.
Carter, C. B., Chicago, Ill.
Ceder, J. G., Chicago, Ill.
C. F. Foss & Co., Lowell, Mass.
Chas. F. Schultz & Co., Danville, Ill.
Churchyard, Joseph J., Buffalo, N. Y.
Corbett, Geo. W., Washington, D. C.
Corse & Jeffrey, Chicago, Ill.
Covert, Geo. S., Meridian, Miss.
Craig, Wm. B., Mankato, Minn.
C. Thomas & Son, Washington, D. C.
D. & F. Betts, Rutland, Vt.
Dahlgreen, J. A., Kansas City, Mo.
Dawson, Alexander, Toledo, Ohio.
Dodsen, Emory F., Minneapolis, Minn.
Doerzback, Geo. W., Sandusky, O.
Driscoll, Daniel A., Washington, D. C.
Dugan Cut Stone Co., Kansas City, Mo.
Dunperley Co., Columbus, O.
E. A. Wilson & Co., Macon, Ga.
Edwards, Hugh R., Racine, Wis.
E. Earnshaw & Co., Chicago, Ill.
Eggers & Brock, South Omaha, Neb.
Empire Fireproofing Co., Pittsburgh, Pa.
F. Martens & Sons, Cumberland, Md.
Foster & Smith, Ashland, Neb.
Fourchy, Andre, New Orleans, La.
Gay, T. F., New Bedford, Mass.
G. D. Gray & Co., New Orleans, La.
Gebhardt & Warner, Helena, Mont.
Geddis & Seerie, Denver, Col.
General Contracting Co., Atlanta, Ga.
Georgia Marble Co., Macon, Ga.
G. H. Morrow & Son, Baltimore, Md.; New York, N.Y.
Gindele, C. W , Chicago, Ill.
Giugrass & Busby, Shreveport, La.
Gobel, E. F., Chicago, Ill.
Grace & Hyde & Co., Chicago, Ill.
Grant, Geo. F., St. Paul, Minn.
Grant, Geo. M., New Haven, Conn.
Grant, James H., Washington, D. C.
Green, W. C., Chicago, Ill.
Gruzard, Thomas L , Columbus, Ga.
Gude & Walker, Atlanta, Ga.
Guernsey, Geo. H., Montpelier, Vt.
Guy, Andrew D., Helena, Mont.
Habau, A. J., St. Paul, Minn.
H. Downes & Sons, Minneapolis, Minn.
Heidenrich & Co., Chicago, Ill.
Hendricks, Martin, Washington, D. C.
Hennessy Bros. & Co., St. Paul, Minn.
Hepburn, Peter, Washington, D. C.
Hildebrant, F., Chicago, Ill.
Hinckley, H. N., Vineyard Haven, Mass.
Horn, Milton H., New Bedford, Mass.
Howlett, J. H., Washington, D. C.
H. T. Cushun & Bro., Martinsburg, Va.
Huckstein Brick & Stone Co., Allegheny, Pa.
H. Wales Lines Co., Meriden, Conn.
Hyde, Benj., Chicago, Ill.
Illinois Terra Cotta Lumber Co, Chicago, Ill.
Ittna, Nicholas, Atlanta, Ga.
Jettner, W., Atlanta, Ga.
Jewett, George H., Arlington, Neb.
J. G. Wedgeworth & Co., Meridian, Miss.
Jobst, B. J., Omaha, Neb.
J. S. Day & Co., Newark, N. J.
J. W. Cotteral & Co., Cincinnati, O.
Killian, Louis, Haverhill, Mass.
King, Orlando J., Omaha, Neb.
Kleinschmidt Bros., Mankako, Minn.
Kinney, Chas. D., New Haven, Conn.
Lamad, S., Savannah, Ga.
Lane & Malnale, Washington, D. C.
Lane, B. D., Chester, Pa.
Lee Fireproof Construction Co., New York, N. Y.
Lenecheek & Thwaits, Minneapolis, Minn.
L. L. Leach & Son, Chicago, Ill.
Leonard, S. S., Mobile, Ala.
Loevell & Hood, Brownwood, Texas.
L. Wallace & Son, Cedar Rapids, Iowa.
Macon, G. T., Dallas, Texas.
Manning & Parsons, Washington, D. C.
McAfee, W. W., Atlanta, Ga.
Marsh, Charles, Newark, N. J.
M. C. Forster & Son, Waterville, Me.
McLeod, J. M., New Bedford, Mass.
McGrutte, Thomas, Newark, N. J.
Mead, Mason & Co., Concord, N. H.
Miles & Bradt, Atlanta, Ga.
Miller, J. W., St. Paul, Minn.
Minneapolis Stone Co, Minneapolis, Minn.
Minnesota Stone Co., Minneapolis, Minn.
Monroe, C. R., Washington, D. C.
Moran, M. J., Fargo, S. Dak.
Morrison Bros., Chicago, Ill.
Morrow Bros., Baltimore, Md.
Moses, Charles A., Chicago, Ill.
Moses, E. A , Chicago, Ill.
Neale & Nesbitt, Atchison, Kan.
Neall, M. N., Cedar Rapids, Iowa.
Nelson & Bassett, Austin, Ill.
Nelson, S., Dallas, Texas.
Nicols & Crothers, Tacoma, Wash.
Norcross Bros., Worcester, Mass.
O'Brien, Wm. H., St. Louis, Mo.
Ohio Hollow Brick Co., Canton, O.
O'Neal, Thomas H., St. Louis, Mo.
Orn & Lawrence, Boston, Mass.
Oschwald, James, Newark, N. J.
Paige, Tom, Cleveland, O.
Paggett, B. R., Atlanta, Ga.
Parker Russell Mining Co., St. Louis, Mo.
Peck, F. H., Atlanta, Ga.
Pierce, John, New York, N. Y.
Pioneer Fireproofing Co., Chicago, Ill.
Pittsburg Terra Cotta Lumber Co., Pittsburg, Pa.
Prescott & Buckley, Plattsburg, N. Y.
Probst Construction Co., Chicago, Ill.
Randall, J. S., Portland, Me.
R. D. Cole Mfg. Co., Newnan, Ga.
Reagan, Th. J., Newark, N. J.
Richardson & Burgess, Washington, D. C.
R. M. Jack & Co., Martinsburg, Ga.
Robt. M. Jack & Son, Canton, O.
Sanford & Brooks, Baltimore, Md.
Sargent, Cuthbert, Topeka, Kan.
Schenk, Henry, Erie, Pa.

Schriver, Lorman P., Chicago, Ill.
Schultz & Warnecke, Sheboygan, Wis.
Scully, M. P., Chicago, Ill.
Slumter, Clayton B., Chester, Pa.
Smith, Wm. R., Fall River, Mass.
Somerfield & Emmons, Dallas, Tex.
Staples Bros., Lowell, Mass.
Stewart, C. D., New Orleans, La.
Sweat, Cummins & Co., Richmond, Vt.
Thomas Clark & Sons, Chicago, Ill.
Thomas H. Stanley & Co., New York, N. Y.
Thomas, J., Washington, D. C.
Thomlinson, John, Chicago, Ill.
Touglaw, Fr. I., Medina, Pa.
Umbrecht, Chas., Syracuse, N. Y.
Valentine, Martin & Co., Martinsburg, Va.
Vanderbrook & Burkett, Jackson, Tenn.
Vermont Marble Co., Proctor, Vt.
Walkup, A. M., Philadelphia, Pa.
Watson, Bliss & Sons, Hartford, Conn.
W. C. Green & Co., Chicago, Ill.
W. E. Speir & Co., Washington, D. C.
Westenhauer, S. A., Martinsburg, Va.
White, Wm. P., St. Joseph, Mo.
Wilcutt, L. D., Boston, Mass.
Wilson, Ansen, Cincinnati, O.
Wortman, D. P., Helena, Mont.
Wrigh, L. P., Dallas, Texas.
Yeager & Schultz, Danville, Ill.

HOUSES—FRAME.

Amberg Granite Co., Chicago, Ill.
Anderson, Andrew, Detroit, Mich.
Anderson Bros., St. Louis, Mo.
Armstrong, Underwood, Detroit, Mich.
Bacon & Brennan, Troy, N. Y.
Baldwin, Frank, Washington, D. C.
Barr & Creelman, Rochester, N. Y.
Bassford, Asa, Philadelphia, Pa.
Bassford, A., Minneapolis, Minn.
Blake & Williams, New York, N. Y.
Carew, Henry, Detroit, Mich.
Chapston, A., Jr., Detroit, Mich.
Corbett, Geo. W., Washington, D. C.
Corse & Jeffrey, Chicago, Ill.
Driscoll, D. A., Washington, D. C.
E. Mayhew & Son, Detroit, Mich.
Empire Fireproofing Co., Pittsburg, Pa.
E. W. Martin & Son, Troy, N. Y.
Forster & Smith, Minneapolis, Minn.
Franklin, A. B., Boston, Mass.
Gearing, Joseph L., Detroit, Mich.
G. H. Morrow & Son, Baltimore. Md.
Hanson, Hayden & Owen, Grand Rapids, Mich.
J. Carlisle & Sons, Minneapolis, Minn.
Kansas City Building & Construction Co., Kansas City, Mo.
Kelly, V. A., Leavenworth, Kan.
Leo Schreible & Co., Detroit, Mich.
L. L. Leach & Co., Chicago, Ill.
M. Blay & Sons, Detroit, Mich.
Minnesota Stone Co., Minneapolis, Minn.
O'Neal, Thomas H., St. Louis, Mo.
Pierce, John, New York City, N. Y.
Pittsburg Lumber Co., Pittsburg, Pa.
Reich, Wm., Detroit, Mich.
Robert Dunn & Co., Detroit, Mich.
Rogers, N. J., Detroit, Mich.
Sheely & Dirkman, Toledo, O.
Spitzley Bros., Detroit, Mich.
Teakle & Golden, Detroit, Mich.
Thomas Bagnall & Co., Plattsburg, N. Y.
Umbrecht, Charles, Syracuse, N. Y.
Vinton & Co., Detroit, Mich.
Wallace & Morris, Detroit. Mich.
Wortman, D. P., Helena, Mont.
Ziegler & Dalton, Junction City, Kan.

PLUMBING.

Babcock & O'Donnell, Syracuse, N. Y.
Baldwin, Frank, Washington, D. C.
Ballard, S. K., Auburn, Me.
Bassford, Asher, Philadelphia, Pa.
Briggs, E. D. Aurora, Ill.
Brown & Trika, Cedar Rapids, Iowa.
Carlisle, James, Minneapolis, Minn.
C. H. Gridley & Co., Elmira, N. Y.
Churchyard, J. J., Buffalo, N. Y.
Columbus, Thomas & Son, Washington, D. C.
Corbett, Geo. W., Washington, D. C.
Costello, Thomas, Plattsburg, N. Y.
Cray, Wm. H. M., Washington, D. C.
Crook, Horner & Co., Baltimore, Md.
C. Thomas & Son, Washington, D. C.
Dalton & Co., Chicago, Ill.
Dawson Construction Co., Toledo, Ohio.
Dixey, M. S., Philadelphia, Pa.
E. Earnshaw & Co., Chicago, Ill.
E. Fitzgerald & Sons, Albany, N. Y.
Foster & Smith, Minneapolis, Minn.
G. H. Morrow & Son, Baltimore, Md.
Gindele, Chas. W., Chicago, Ill.
G. S. Blodgett Co., Burlington, Vt.
Hall, M. M., Cedar Rapids, Iowa.
Hall, W. J., Lewiston, Me.
Hayde & Co., Kansas City, Mo.
Hoglin, Chas. G., Minneapolis, Minn.
Holtzclaw Bros., Hampton, Va.
Hughes & Keith Plumbing Co., Denver, Colo.
John O'Neill & Sons, Peoria, Ill.
Joy, Edward, Syracuse, N. Y.
J. T. Schneider & Co., Atlanta, Ga.
J. W. Swanson & Co., Washington, D. C.
Lenox & Halderman, Chicago, Ill
L. L. Leach & Sons, Chicago, Ill.
Mafiola, Giacomo, Rockford, Ill.
M. C. Foster & Son, Waterville, Me.
Monteith, J. W., Rockford, Ill.
Mooney & Banes, Nashville, Tenn.
M. Yeager & Son, Danville, Ill.
O'Brien, Wm. H., St. Louis, Mo.
Olds & Whipple, Hartford, Conn.
Oliver, Henry, Charleston, S. C.
O'Neil, Thomas H., St. Louis, Mo.
Porter, C. H., Rockford, Ill.
Prescott & Buckley, Plattsburg, N. Y.
Priddy-Dunlap Pump Co., Roanoke, Va.
Reley, A. J., Charleston, S. C.
Robert M. Jack & Sons, Martinsburg, W. Va.
Schureman & Cook, Rockford, Ill.
Shover, James E., Indianapolis, Ind.
Shriver, Lorman P., Chicago, Ill.
Spraul & McGurrin, Grand Rapids, Mich
Thomas Clark & Son, Chicago, Ill.
Umbrecht, Charles, Syracuse, N. Y.
Van Wie, Wm. T., Amsterdam, N. Y.
Walkup, A. M., Philadelphia, Pa.
White, Wm. P., St. Joseph, Mo.
W. W. Sykes & Co., Minneapolis, Minn.
Yinger, George S., York, Pa.
Ziegler & Dalton, Junction City, Kan.

HEATING.

Allen Black & Co., Duluth, Mich.
American Boiler Co., New York City.
Babcock & Wilcox Co., New York, N. Y.
Baizley, John, Philadelphia, Pa.

Baker, Smith & Co., New York, N. Y.
Baldwin, F., Washington, D. C.
Balfe & Reed, Omaha, Neb.
Bates, Edward P., Syracuse, N. Y.
Bagley Heating Co., Milwaukee, Wis.
Bixby, J. C., Council Bluffs, Iowa.
Blake & Williams, New York, N. Y.
Campbell, Zell & Co., Baltimore, Md.
C. B. Kruse Heating Co., Milwaukee, Wis.
Chaefer & Becker, Cleveland, Ohio.
Clark, Robert, Peoria, Ohio.
Cook, Homer & Co., Baltimore, Md.
Crook, Horner & Co., Baltimore, Md.
C. Thomas & Son, Washington, D. C.
Dalton, J. F., Chicago, Ill.
Farrell & Meeker, Chicago, Ill.
Fosberg & Murry, Washington, D. C.
Fourstead & Moore, Minneapolis, Minn.
Franklin, A. B., Boston, Mass.
Franklin, G., New York, N. Y.
Grant Furnace Co., New York, N. Y.
Gilles & Geoghegan, New York, N. Y.
G. S. Blodgett, Burlington, Vt.
Gurney Heater Co., Boston, Mass.
Hart & Crouse, New York, N. Y.
H. B. Smith Co., New York, N. Y.
Heine Safety Boiler Co., St. Louis, Mo.
Herendeen Mfg. Co., Geneva, N. Y.
Hilbard, J. D., Chicago, Ill.
Hitchings & Co., New York, N. Y.
Huette-Barler Mfg. Co., Chicago, Ill.
James Curran Mfg. Co., New York, N. Y.
Jenkins, Joseph, Wilmington, Del.
Jordon, Roberts, Chicago, Ill.
Joy, Edward, Syracuse, N. Y.
J. T. Foley & Co., Evansville, Ind.
Leonard, B. E., Scranton, Pa.
L. W. Straus & Sons, Dunville, Ill.
Lynch & Woodward, Boston, Mass.
Lyon, John, Washington, D. C.
Mackabee, D. F., Washington, D. C.
Magee Furnace Co., Boston, Mass.
Martin, Edward, Syracuse, N. Y.
McCauley Bros. Grand Rapids, Mich.
Morrison, W. C., Washington, D. C.
Nepil, A. O., St. Paul, Minn.
Onderdonk Heating Co., Philadelphia, Pa.
Pettit & Dripps, Washington, D. C.
Pond & Husey Co., Minneapolis, Minn.
Pope, S. I., Chicago, Ill.
Richardson & Boynton Co., New York, N. Y.
Rochester Stove Co., Rochester, N. Y.
Rutzler, Edward, Pres. Steam Heaters' Association, New York, N. Y.
Spear & Co., Philadelphia, Pa.
Stradling Plumbing & Heating Co., Utica, N. Y.
Sweeny, P. J., Albany, N. Y.
Waidson Heater Co., Geneva, N. Y.
Walworth Co., Boston, Mass.
Warren W. Briggs & Co., Washington, D. C.
Welshaws & Co., Omaha, Neb.
W. E. Spear & Co., Washington, D. C.
Winfee, W. U., Washington, D. C.
Wm. Roger & Co., St. Paul, Minn.
Zeller & Co., Washington, D. C.

ROOFING.

Anderson Bros., St. Louis, Mo.
Barnard, Geo. A., Worcester, Mass.
Brown & Dubney, Dallas, Tex.
Geo. H. Evans & Co., Topeka, Kan.
Gobel, E. F., Chicago, Ill.
Harrington, J. J., Washington, D. C.
Hutton Bros. & Co., Detroit, Mich.
Hyde, Benj., Chicago, Ill.
Jacob Freund Roofing Co., Cincinnati, Ohio.
Jacob Riggle & Sons, Jersey City, N. J.
J. A. Miller Bros., Chicago, Ill.
Jobst Bros., Omaha, Neb.
L. L. Leach & Son, Chicago, Ill.
Lovell & Hood, Hillsboro, Tex.
Mullins, W. H., Worcester, Mass.
Morgan, Dan, Dallas, Tex.
Norcross Bros., Worcester, Mass.
Orth, A. J., Detroit, Mich.
Power, Peter, Salem, Mass.
R. M. Jack & Co., Detroit, Mich.
Smith & Bardon, Fort Worth, Tex.
Stevenson, F. L., Dallas, Tex.
W. C. Green & Co., Chicago, Ill.
Whitehead & Lewis, Detroit, Mich.

ELEVATORS.

Brodresser Elevator Co., Milwaukee, Wis.
Central Machine and Foundry Co., Quincy, Ill.
Clarke, Robert, Peoria, Ill.
Crane Elevator Co., Chicago, Ill.
Eaton & Prince, Chicago, Ill.
Graves Elevator Co., Rochester, N. Y.
Haven, James S., Cincinnati, Ohio.
H. J. Reedy & Co., Cincinnati, Ohio.
Howard Foundry and Machine Works, Philadelphia, Pa.
J. W. Reedy Elevator Co., Chicago, Ill.
Marsh Elevator Co., New York, N. Y.
M. J. O'Donnell Co., Cleveland, O.
Moore & Williams, Philadelphia, Pa.
Morse, Williams & Co., Philadelphia, Pa.
Otis Brothers, New York, N. Y.
South Hill Elevator Co., Quincy, Ill.
Sprague Electric Elevator Co., New York, N. Y.
Standard Elevator Co., Chicago, Ill.
Stokes & Parrish, Philadelphia, Pa.

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MACHINERY.
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EAST.
LAKE REGIONS.
SOUTH.
FAR WEST.

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AIR COMPRESSORS.

Deane Steam Pump Co., Holyoke, Mass.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y. City.
Clayton Air Compression Works, 26 Cortlandt St,, N. Y. City.
Rand Drill Co., 23 Park Place, N. Y. City.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio ; 45 N. 7th St., Philadelphia, Pa.; 410 Lewis Block, Pittsburg, Pa.; 68-70 S. Canal St., Chicago, Ill.
Walker Mfg. Co., Cleveland, Ohio.
Dow Steam Pump Works, 114-116 Beale St., San Francisco, Cal.

ALUMINUM.

F. L. Gaylord Co., Ansonia, Conn.
Haight & Clark, Albany, N. Y.
Pratt & Cady Co., Hartford, Conn.
Waldo Foundry, Bridgeport, Conn.
Pittsburgh Testing Laboratory, 116 Water St., Pittsburg, Pa.
Pittsburg Reduction Co., Pittsburg, Pa.

ANCHORS.

DeGrauw Aymer & Co., 34 and 35 South St., N. Y. City
Upson-Walton Co,, Cleveland, Ohio.
H. D. Edwards & Co., Detroit, Mich.
G. B. Carpenter & Co., Chicago, Ill.

ANVILS.

Eagle Anvil Works, Trenton, N. J.

ARCHITECTURAL IRON.

Continental Iron Works, Brooklyn, N. Y.
Berlin Iron Bridge Co., Berlin, Conn.
Sternbergh & Son, Reading, Pa.
Van Dorn Iron Works Co., Cleveland, Ohio.
Winslow Bros. Co., Chicago, Ill.
E. T. Barnum, Detroit, Mich.
Ludlow Saylor Wire Co., St. Louis, Mo.
See "Bridges" and "Building Materials" also.

ASPHALT PAVING.

Barber Asphalt Paving Co., No. 1 Broadway, N. Y. City and Washington, D. C.
Neuchatel Asphalt Co., 265 Broadway, N. Y. City.
New York & Bermuda Co., 25 Beaver St., N. Y. City.
Sicilian Asphalt Paving Co., "Times" Building, N. Y. City.
Warren-Sharf Asphalt Paving Co., 81 Fulton St., N. Y. City.
E. H. Wooton (Seyssel Rock Asphalt), 35 Broadway, N. Y. City.

ASPHALT ROOFING.

E. Van Noordan & Co., Harrison Ave., Boston, Mass.
A. E. Filley, Mfg. Co., 39 Cortlandt St., N. Y. City.
Warren Chemical & Mfg. Co., 81 Fulton St., N. Y. City.
Memphis Iron Roofing & Corrugating Works, Memphis, Tenn.

AXES.

A. G. Peck & Co., Cohoes, N. Y.
Fayette R. Plumb, Philadelphia, Pa.

BABBITT METAL.

See METALS, ANTI-FRICTION.

BELTS.

Boston Belting Co., 256 Devonshire St., Boston, Mass.
Manhattan Rubber Mfg. Co., 64 Cortlandt St., N. Y. City.
New York Belting and Packing Co., N, Y. City.
Peerless Rubber Mfg. Co., 15 Warren St., N. Y. City.
Home Rubber Co., Trenton, N. J.
Main Belting Co., Philadelphia, Pa.
Link Belt Mfg. Co,, Philadelphia, Pa.
Roberts Mfg. Co., Pittsburg, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
Shultz Belting Co., St. Louis, Mo.
J. L. Lindsay, Richmond, Va.
Cameron & Barkley, Charleston, S. C.
See Boston Belting Co., under HOSE.

BELT DRESSINGS.

Joseph Dixon Crucible Co., Jersey City, N. J.

BELT FASTENERS.

Bristol Co., Waterbury, Conn.
Sawyer Hardware and Supply Co., Pawtucket, R. I.
W. O. Talcott, Providence, R. I.

BLASTING MATERIALS.

Am. Powder Mill, 233 State St., Boston, Mass.
Rendrock Powder Co., 23 Park Place, N. Y. City.
Laflin & Rand Powder Co., 29 Murray St., N. Y. City.
New York Powder Co., 62 Liberty St., N. Y. City.
Atlantic Dynamite Co., 245 Broadway, N. Y. City.
The Hecla Powder Co., 239 Broadway, N. Y. City.
Arthur Kirk & Son, Pittsburg, Pa.
Aetna Powder Co., Chicago, Ill.
American Powder Co., 206 Olive St., St. Louis, Mo.

BLOWERS.

See VENTILATING APPARATUS.

BOATS, ROW.

James Burcher, 822 Swanson St., Philadelphia, Pa.
J. H. Rushton, Canton, N. Y.
See also "LAUNCHES" and "SHIP-BUILDERS."

BOILERS.

Atlantic Works, East Boston, Mass.
Hodge & Co., East Boston, Mass.
Continental Iron Works, Brooklyn, N. Y.
Abendroth & Root Mfg. Co., 28 Cliff St., N. Y. City.
J. S. Mundy, Newark, N. J.
Pennsylvania Machine Co., Philadelphia, Pa.
Southwark Foundry and Machine Co., Philadelphia, Pa.
Robert Wetherill & Co., Chester, Pa.
H. E. Collins & Co., Pittsburg, Pa.
Lake Erie Iron Works, Buffalo, N. Y.
Globe Iron Works, Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.
Stirling Co., Chicago, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
Robt. Poole & Sons Co., Baltimore, Md.
Talbott & Sons, Richmond, Va.
Bailey Libbey Co., Charleston, S. C.
Valk & Murdoch, Charleston, S. C.
Heine Safety Boiler Co., St. Louis, Mo.
Union Iron Works, First and Mission Sts., San Francisco, Cal.

BOILERS, CORRUGATED.

Continental Iron Works, Brooklyn, N. Y.

BOILERS, WATER-TUBES.

Murray & Tregurtha, South Boston, Mass.
Roberts Safety Water-Tube Boiler Co., 39–41 Cortlandt St., N. Y. City.
Abendroth & Root Mfg. Co., 28 Cliff St., N. Y. City.
C. D. Mosher, 1 Broadway, N. Y. City.
Chas. L. Seabury & Co., Exchange Building, 52 Broadway, N. Y. City.
Almy Water-Tube Boiler Co., Providence, R. I.
Ward Water-Tube Boiler Co., Charleston, Kanawha Co., W. Va.
Adams Water-Tube Boiler Co., Cleveland, Ohio.
Sterling Co., Pullman Building, Chicago, Ill.
Finlayson Water-Tube Boiler Co., Box 128. Detroit, Mich.
Robt. Poole & Sons Co., Baltimore, Md.

BOILER COMPOUNDS.

Litofuge Mfg. Co., 62 John St., N. Y. City.
Geo. W. Lord, Philadelphia, Pa.

BOILER AND PIPE COVERINGS.

S. C. Nightingale & Childs, 134 Pearl St., Boston, Mass.
Robt. A. Keasby, 54 Warren St., N. Y. City.
H. W. Johns Mfg. Co., 87 Maiden Lane, N. Y. City.
McKan Co., 1420 Callowhill St., Philadelphia, Pa.
Keasbey & Mattison Co., 114 W. Second St., Cincinnati, Ohio; 117 Water St., Cleveland, Ohio.
Walch & Wyeth, 208 Lake St., Chicago, Ill.
S. P. Conklin, 20 E. Atwater St., Detroit, Mich.
F. Sprinkman, 133 Sycamore St., Milwaukee, Wis.
F. Bocler, 108 Walnut St., St. Louis, Mo.
Wallace & Bro., 432 E. Pratt St., Baltimore, Md.
Delbert Engineering Co., New Orleans, La.
Symmes & Co, 162 Front St , Memphis, Tenn.
C. W. Badgeley & Co., 18th and Market Sts., Denver, Colo.
De Solla & Deussing, 2 California St., San Francisco, Cal.

BOILER FRONTS AND FITTINGS.

C. H. McCutcheon, Buffalo, N. Y.
Morris, Tasker & Co., Philadelphia, Pa.
Vulcan Iron Works, Toledo, Ohio.
Bassett Presley & Train, Cleveland, Ohio.
Reliance Gage Co., Cleveland, Ohio.
Robt. E. Hills, 57–59 N. Wells St., Chicago, Ill,

BORING MACHINES.

Waterman Machine Tool Co., Oakland, Me.

BOLTS, NUTS, AND WASHERS.

American Bolt Co., Lowell, Mass.
Blake & Johnson, Waterbury, Conn.
Dunham Nut Co., Unionville, Conn.
J. Fred. Wilson, Worcester, Mass.
Mount Carmel Bolt Co., Mount Carmel, Conn.
Port Chester Bolt and Nut Co., Port Chester, N. Y.
Russell, Burdsall & Ward, Port Chester, N. Y.
Wm. H. Haskell Co., Pawtucket, R. I.
Rhode Island Tool Co., Providence, R. I.
J. H. Sternbergh & Son, Reading, Pa.
Pennsylvania Bolt and Nut Co., Lebanon, Pa.
American Iron and Bolt Co., Cincinnati, Ohio.
Cincinnati Screw and Tap Co., Cincinnati, Ohio.
Detroit Valve and Washer Co., Detroit, Mich.
Payne Bros., 121–123 Howard St., San Francisco, Cal.

BRAKES.

New York Air-Brake Co., 115 Broadway, N. Y. City.
Westinghouse Air-Brake Co., Pittsburg, Pa.
American Brake Co., Pittsburg, Pa.
Beamless Brake Co., Bloomsburg, Pa.
National Hollow Brake Beam Co., 40th and Hopkins Sts., Chicago, Ill.

BRASS, BRONZE, AND COPPER.

Randolph & Clowes, 99 Milk St., Boston, Mass.
G. Douglas Petrie, 39–41 Cortlandt St., N. Y. City.
Randolph & Clowes, 104 John St., N. Y. City.
Haight & Clark, Albany, N. Y.
Pratt & Cady Co., Hartford, Conn.
Waldo Foundry, Bridgeport, Conn.
Wm. Camp & Sons Ship and Engine Building Co., Philadelphia, Pa.
Merchant & Co., Philadelphia, Pa.
Pennsylvania Brass Co., Erie, Pa.
C. H. McCutcheon, Buffalo, N. Y.
Randolph & Clowes, 71 Washington St., Chicago, Ill.
Detroit Sheet Metal and Brass Works, 64–72 Orleans St., Detroit, Mich.
American Foundry Co., Tacoma, Washington.

BRICK AND TILE.

Blanford Brick & Tile Co., Boston, Mass.
Calvin Tompkins, 150 Broadway, N. Y. City.
Henry Maurer & Son, 420 E. 23d St., N. Y. City.
John H. Jackson, Albany, N. Y.
Buffalo Star Brick Co., Buffalo, N. Y.
Park Fire Clay Co., Pittsburg, Pa.
Freeman Fire Clay Co., Freeman, Ohio.
Monmouth Mfg. Co., Monmouth, Ill.
White Hall Fire Clay Works, White Hall, Ill.
Chicago Anderson Pressed Brick Co., 189 La Salle St., Chicago, Ill.
Baker & Billings, Minneapolis, Minn.

Burnham Bros., Milwaukee, Wis.
Evans & Howard, 916 Market St., St. Louis, Mo.
Burns, Russell & Co., Baltimore, Md.
Chester Clay-Working Co., Richmond, Va.
New Orleans Brick and Tile Co.. New Orleans, La.
Abbott, Morse & Co., Kansas City, Mo.
Argo Brick Mfg. Co., Denver, Colo.

BRICK, FIREPROOF.

B. Kreishcher & Sons, ft. of E. Houston St., N. Y. City.
H. Maurer & Son, 420 E. 23d St., N. Y. City.
Ostrander Fire-Brick Co.; Troy, N. Y.
John H. Jackson, Albany, N. Y.
Syracuse Stone Ware Agency, Syracuse, N. Y.
Cyrus Borgner, Philadelphia, Pa.
Fayette Mfg. Co., Pittsburgh, Pa.
Dover Fire-Brick Co., Cleveland, Ohio.
Evans & Howard, 916 Market St., St. Louis, Mo.
Jas. Gardner & Sons, Cumberland, Md.
Montague & Co., Chattanooga, Tenn.

BRIDGES.

Boston Bridge Works, Boston, Mass.
Berlin Iron Bridge Co., E. Berlin, Conn.
Melan Construction Co., 71 B'way, N. Y. City.
Buffalo Bridge & Iron Works, Buffalo, N. Y.
Groton Bridge Mfg. Co., Groton, N. Y.
Rochester Bridge & Iron Works, Rochester, N. Y.
L. P. Evans, Philadelphia, Pa.
Pencoyd Bridge & Construction Co., Pencoyd, Penn.
Union Bridge Co., Athens, Pa.
Phœnix Bridge Co., Phœnixville, Penn.
Penn Bridge Co., Beaver Falls, Pa.
Shiffler Bridge Co., Pittsburg, Pa.
Schultz Bridge & Iron Co., Pittsburg, Pa.
King Bridge Co., Cleveland, Ohio.
Variety Iron Works Co., Cleveland, Ohio.
Chicago Bridge & Iron Co., Washington Heights, Chicago, Ill.
Gagnier-Griffin Suspended Railway Bridge Co., 1026 Masonic Temple, Chicago, Ill.
Detroit Bridge & Iron Works, Detroit, Mich.
F. H. Smith, Baltimore, Md.
Vaile & Young, Baltimore, Md.
San Francisco Bridge Co., San Francisco, Cal.

BUILDING MATERIALS.

Berlin Iron Bridge Co., E. Berlin, Conn.
A. E. Filley Mfg. Co., 39 Cortland St., N. Y. City.
Henry Maurer & Son, 420 E. 23d St., N. Y. City.
H. W. Johns Mfg. Co., 87 Maiden Lane, N. Y. City.
Warren Chemical & Mfg. Co., 27 Fulton St., N. Y. City.
James G. Wilson, 74 West 23d St., N. Y. City.
Wm. Heinrich & Son, 193 Spring St., Buffalo, N. Y.
Jos. Dixon Crucible Co., Jersey City, N. J.
Harrison Bros. & Co., Philadelphia, Pa.
Sam'l. H. French & Co., Philadelphia, Pa.
Empire Fireproofing Co., Pittsburg, Pa.
Sternbergh & Son, Reading, Pa.
Canton Steel Roofing Co., Canton, Ohio.
E. B. Moore & Co., Chicago, Ill.
Pioneer Fireproof Construction Co., Chicago, Ill.
Winslow Bros. Co., Chicago, Ill.
Andrew Volk, Baltimore, Md.
Stillwell, Millen & Co., Savanah, Ga.

BUILDING MATERIALS, FIREPROOF.

Berlin Iron Bridge Co., E. Berlin, Conn.
H. W. Johns Mfg. Co., 87 Maiden Lane, N. Y. City.
Henry Maurer & Son, 420 E. 23d St., N. Y. City.
A. E. Filley Mfg. Co., 39 Cortlandt St., N. Y. City.
Sternbergh & Son, Reading, Pa.
Empire Fireproofing Co., Pittsburg, Pa.
Canton Steel Roofing Co., Canton, Ohio.
Pioneer Fireproof Construction Co., Chicago, Ill.

CABLES, ELECTRIC.

General Electric Co., 44 Broad St., N. Y. City.
Bishop Gutta-Percha Co., 420 E. 25th St. N. Y. City.
Morris Tasker & Co., Philadelphia, Pa.
Chicago Electric Co., Wilmington, Del.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
California Electric Works, 35 Market St., San Francisco.

CABLES-WIRE.

Washburn & Moen Mfg. Co., Worcester, Mass.
John Roebling Sons Co., 117 Liberty St., N. Y. City; 173 Lake St., Chicago, Ill; 59 Wade B'ld'g, Cleveland, Ohio; 25 Fremont St., San Francisco, Cal.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y. City.
Trenton Iron Co., Trenton, N. J.
Hazard Mfg. Co., Wilkesbarre, Pa.
Lebanon Chain Works, Lebanon, Pa.
Carpenter & Co., 207–209 S. Water St., Chicago, Ill.
Broderick & Bascomb Rope Co., St. Louis, Mo.
A. Leschen & Sons Rope Co., St. Louis, Mo.
California Wire Works, San Francisco, Cal.

CABLE RAILWAY PLANTS.

Christie & Lowe, 45 Broadway, N. Y. City.
Robt. Wetherill & Co., Chester, Pa.
Walker Mfg. Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
Robt. Poole & Son Co., Baltimore, Md.

CARBONS FOR DIAMOND DRILLS.

S. D. Dessau, 4–6 John St., N. Y. City.

CARS.

Wason Mfg. Co., Brightwood, Mass.
New York Equipment Co., 15 Wall St., N. Y. City.
Ensign Mfg. Co., 11 Pine St., N. Y. City; Huntington, W. Va.
Delaware Car Works, Wilmington, Del.
J. G. Brill Co., Philadelphia, Pa.
Standard Steel Works, 220 S. Fourth St., Philadelphia, Pa.
Midvale Steel Co., Philadelphia, Pa.
Allison Mfg. Co., Philadelphia, Pa.
Bloomsburg Car Co., Bloomsburg, Pa.
Carlisle Mfg. Co., Carlisle, Pa.
Milton Car Works, Milton, Pa.
Youngstown Car Mfg. Co., Youngstown, Ohio.
Sheffield Car Co., Three Rivers, Mich.
Tredegar Iron Works, Richmond, Va.
Memphis Car and Foundry Co., Memphis, Tenn.
St. Charles Co., St. Charles, Mo.

CARS, DUMPING AND HAND.

G. L. Steubner & Co., Long Island City, N. Y.
Allison Mfg. Co., Philadelphia, Pa.
Bloomsburg Car Co., Bloomsburg, Pa.
Carlisle Mfg. Co., Carlisle, Pa.
Jackson & Woodin Mfg. Co., Berwick, Pa.
Buda Foundry and Mfg. Co., Harvey, Ill.
Sheffield Car Co., Three Rivers, Mich.

CAR AXLES AND COUPLERS.

Gould Coupler Co., 66 Broadway, N. Y. City.
Cambria Iron Co., Philadelphia, Pa.
Johnston Coupler Co., 204 Walnut Place, Philadelphia, Pa.
Smille Coupler Co., 91 Clay St., Newark, N. J.
Chas. D. Gibbons, 202 Society of Savings Building, Cleveland, Ohio.
McConway & Torley Co., Pittsburg, Penn.

National Malleable Castings Co., 1525 Old Colony Building, Chicago, Ill.
Tredegar Iron Work, Richmond, Va.
Memphis Car and Foundry Co., Memphis, Tenn.
American Foundry Co., Tacoma, Wash.

CAR LUBRICANTS.

See LUBRICANTS.

CAR WHEELS.

See WHEELS.

CASTINGS, IRON AND STEEL.

Boston Casting Co., S. Boston, Mass.
Chrome Steel Works, Brooklyn, N. Y.
Burr & Houston Co., Brooklyn, N. Y.
Continental Iron Works, Brooklyn, N. Y.
Buffalo Forge Co., Buffalo, N. Y.
Haight & Clark, Albany, N. Y.
Flagg, Stanley G., & Co., Philadelphia, Pa.
R. D. Wood & Co., Philadelphia, Pa.
Walker Mfg. Co., Cleveland, Ohio.
Addyston Pipe and Steel Co., Cincinnati, Ohio.
Fraser & Chalmers, Chicago, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
Shickle, Harrison & Howard Iron Co., St. Louis, Mo.
Robt. Poole & Son Co., Baltimore, Md.
Tredegar Iron Works, Richmond, Va.
Valk & Murdoch, Charleston, S. C.
Chattanooga Foundry and Pipe Works, Chattanooga, Tenn.
American Foundry Co., Tacoma, Wash.

CASTINGS, MALLEABLE.

Arcade Malleable Iron Co., Worcester, Mass.
Torrance Iron Co., Troy, N. Y.
Devlin & Co., Philadelphia, Pa.
National Malleable Castings Co., 1525 Old Colony Building, Chicago, Ill.

CEMENT, "PORTLAND."

Alsen Portland Cement Works, 143 Liberty St., N. Y.
Howard Flemming ("J. B. White Portland"), 10 Pine St., N. Y. City.
Johnson & Wilson ("Saylor's American Portland"), 91 Liberty St., N. Y. City.
E. Thiele ("Dyckerhoff"), 78 William St., N. Y. City.
Atlas Cement Co. ("American Portland"), 143 Liberty St., N. Y. City.
Buckeye Cement Co. ("Portland"), Bellefontaine, Ohio.

CEMENT, "ROSENDALE" AND MISCELLANEOUS.

Lawrence Cement Co. ("Hoffman" Rosendale), 1 Broadway, N. Y. City.
New York and "Rosendale" Cement Co., N. Y. City.
F. O. Norton Cement Co., 90 Broadway, N. Y. City.
Cumberland Hydraulic Cement Co., 67 William St., N. Y. City.
Union Akron Cement Co., Buffalo, N. Y.
Commercial Wood and Cement Co., Girard Building, Philadelphia, Pa.
Leslie & Trinkle, 210 S. Third St., Philadelphia, Pa.
Cincinnati Mortar Mfg. and Building Supply Co., Cincinnati, Ohio.
Masters & Co., 236 Superior St., Cleveland, Ohio.
Meacham & Wright, 98 Market St., Chicago, Ill.
Milwaukee Cement Co., Plankinton Bank B'ld'g, Milwaukee, Wis.
Twin City Lime & Cement Co., St. Paul, Minn.
Black Lime Co., St. Louis, Mo.
Western Cement Co., 247 W. Main St., Louisville, Ky.
S. M. Hamilton, 8 S. Gay St., Baltimore, Md.
Moore, Warner & Co., Richmond, Va.
Wright Lime & Cement Co., Memphis, Tenn.
Howard Hydraulic Cement Co., Chattanooga, Tenn.
New Orleans Shell Lime Mfg. Co., New Orleans, La.
Kansas Cement Works, Kansas City, Mo.
C. A. Brockett Cement Co., Kansas City, Mo.
Colorado Cement Mfg. Co., Denver, Colo.
Pacific Patent Plaster Co., San Francisco, Cal.

CHAINS.

Link Belt Engineering Co., Philadelphia, Pa.
Bradlee & Co., Philadelphia, Pa.
Garland Chain Co., Rankin, Pa.
Empire Chain Works, Beach and Otis Sts., Philadelphia, Pa.
Lebanon Chain Works, Lebanon, Pa.
Jas. McKay & Co., Pittsburg, Pa.

CHAIN PULLEY BLOCKS.

See CRANES.

CHEMICALS & CHEMICAL APPARATUS.

Aimer & Amend, 18th St. & 3d Ave., N. Y. City.
R. D. Wood & Co., Philadelphia, Pa.
Fraser & Chalmers, Chicago, Ill.
Henry Heil Chemical Co., 208–212 Fourth St., St. Louis, Mo.

CHIMNEYS.

Philadelphia Engineering Works, Philadelphia, Pa.

CHISELS.

See TOOLS.

CHUCKS.

Cushman Chuck Co., Hartford, Conn.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., 103 Chambers St., N. Y. City.
Standard Tool Co., Cleveland, Ohio.

CLAY-WORKING MACHINERY.

F. D. Cummer & Son Co., Cleveland, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Vulcan Iron Works, Toledo, Ohio.

CLUTCHES, FRICTION.

A. & F. Brown, 17 Day St., N. Y. City.
Moore & White Co., Philadelphia, Pa.
Volney W. Mason & Co., Providence, R. I.
J. S. Mundy, Newark, N. J.
Walker Mfg. Co., Cleveland, Ohio.
Robt. Poole & Son Co., Baltimore, Md.

CONDENSERS.

Deane Steam Pump Co., Holyoke, Mass.
Wheeler Condensing & Engineering Co., 39–41 Cortlandt St., N. Y. City.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Fraser & Chalmers, Chicago, Ill.
Edw. P. Allis Co., Milwaukee, Wis.

CONTRACTORS' SUPPLIES.

Carson Trench Machine Co., Boston, Mass.
Harold C. Dayton & Co., 44 Day St., N. Y. City.
Wm. Halpin, 47 Washington St., N. Y. City.
C. H. McCutcheon, Buffalo, N. Y.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Link Belt Engineering Co., Philadelphia, Pa.
Thos. Carlin's Sons, Allegheny, Pa.
Geo. B. Carpenter & Co., 202–208 S. Water St., Chicago, Ill.
American Hoist & Derrick Co., St. Paul, Minn.
Urie Dredge Co., Kansas City, Mo.
Milner & Kettig, Birmingham, Ala.
Missouri Dredge Co., Kansas City, Mo.
Risdon Iron Works, San Francisco, Cal.

CONVEYING MACHINERY.

Steel Cable Engineering Co., E. Boston, Mass.
C. W. Hunt Co., 45 Broadway, N. Y. City.
John A. Roebling's Sons Co., Trenton, N. J.
Link Belt Engineering Co., Nicetown, Philadelphia, Pa.
Fraser & Chalmers, Chicago, Ill.
Brown Hoisting & Conveying Machine Co., Cleveland, Ohio.

COPPER.

See BRASS.

CORDAGE.

See ROPE.

CORRUGATED METAL.

Berlin Iron Bridge Co., E. Berlin, Conn.
Continental Iron Works, Brooklyn, N. Y.
Merchant & Co., Philadelphia, Pa.
Jas. A. Miller & Bro., 129–131 S. Clinton St., Chicago, Ill.

CRANES.

Berlin Iron Bridge Co., E. Berlin, Conn.
Yale & Town Mfg. Co., Stamford, Conn.
Earle C. Bacon, 26 Cortlandt St., N. Y. City.
Wm. Sellers & Co., Philadelphia, Pa.
R. D. Wood & Co., Philadelphia, Pa.
Brown Hoisting & Conveying Machine Co., Cleveland, Ohio.
Whiting Foundry Equipment Co., 225 Dearborn St., Chicago, Ill.

CREOSOTING.

Allen Otis & Son, Lowell, Mass.
Eppinger & Russell, First St. and Newtown Creek, L. I. City.
Lehigh Valley Creosoting Works, 1 Broadway, N. Y. City.
Wood Vulcanizing Co., Manhattan Bldg., N. Y. City.
Wyckoff Creosoting Co., Williamsport, Pa.
Michigan Pipe Co., Bay City, Mich.
Old Dominion Creosoting Works, 57 Main St., Norfolk, Va.
Fernoline Chemical Works, Charleston, S. C.
Gerhard Hardware Co., Austin, Texas.

CRUSHING-MACHINES.

Bradley Pulverizer Co., 92 State St., Boston, Mass.
Earle C. Bacon, 26 Cortlandt St., N. Y. City.
American Road Machine Co., Kennett Square, Pa.
Becket Foundry and Machine Works, Arlington, N. J.
Griffith & Wedge Co., Zanesville, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Edw. P. Allis Co., Milwaukee, Wis.

CURRENT-METERS.

Ritchie & Sons, Brookline, Mass.
E. E. Haskell, Sault St. Marie, Mich.

CYLINDER-PACKING.

See PACKING.

DAMPER-REGULATORS.

D'Este & Seeley Co., 29 Haverhill St., Boston, Mass.
Mason Regulator Co., Boston, Mass.
Standard Thermometer Co., Peabody, Mass.

DIAMOND-DRILLS.

Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y. City.
Sullivan Machinery Co., 54–60 N. Clinton St., Chicago, Ill.; Denver, Col.
M. C. Bullock Mfg. Co., Chicago, Ill.

DITCHING-MACHINES.

Carson Trench Machine Co., Boston, Mass.
Osgood Dredge Co., Albany, N. Y.
Moore Mfg. Co., Buffalo, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.
F. C. Austin Mfg. Co., Chicago, Ill.
San Francisco Bridge Co., San Francisco and Seattle.

DIVERS.

Capt. John Williams, Thurlow, Pa.
Joseph G. Falcon, Evanston, Ill.
Thatcher & Breymann, Jefferson and Water Sts., Toledo, Ohio.
Knudson & Son, 874 Washtenaw Ave., Chicago, Ill.

DIVING APPARATUS.

A. J. Morse & Son, 140 Congress St., Boston, Mass.
A. Schraeder & Son, 32 Rose St., New York City.

DRAIN-TILES.

See BRICKS.

DRAWING MATERIALS.

E. L. Deane, Holyoke, Mass.
L. S. Starrett, Athol, Mass.
Brandis' Sons Co., 754–56 Lexington Ave., Brooklyn, N. Y.
Keuffel & Esser, 127 Fulton St., N. Y. City.
Theo. Alteneder, 937 Ridge Avenue, Phila., Pa.
Queen & Co., Phila., Pa.
F. Weber & Co., 1125 Chestnut St., Phila., Pa.
Wm. E. Stieren, 544 Smithfield St., Pittsburg, Pa.

DREDGING MACHINERY.

Eastern Dredging Co., 25 Congress St., Boston, Mass.
New England Dredging Co., 12 Post-Office Square, Boston, Mass.
Atlantic Dredging Co., N. Y. City.
New York Dredging Co., World Bldg., N. Y. City.
Barney Dumping Boat Co., 319 Broadway, N. Y. City.
Joseph Edwards & Co., 412–416 Water St., N. Y. City.
John Haywood, 11 Pine Street, N. Y. City.
Osgood Dredge Co., Albany, N. Y.
J. S. Mundy, Newark, New Jersey.
Hulings Bros., Pittsburg, Pa.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, O., and Chicago, Ill.
Bucyrus Steam Shovel and Dredge Co., South Milwaukee, Mich.
Robt. Poole & Son Co., Baltimore, Md.
Missouri Dredge Co., Kansas City, Mo.
San Francisco Bridge Co., San Francisco and Seattle.

DRILLING-MACHINES.

Dwight Slate Machine Co., Hartford, Conn.
Steam Stone-cutting Co., Rutland, Vermont.
Asa Goddard, Worcester, Mass.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y. City.
Rand Drill Co., 23 Park Pl., N. Y. City.
Buffalo Forge Co., Buffalo, N. Y.
Beaman & Smith, Providence, R. I.
Pennsylvania Machine Co., Philadelphia, Pa.
Bickford Drill and Tool Co., Cincinnati, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Sullivan Machinery Co., Chicago, Ill.
M. C. Bullock Mfg. Co., Chicago, Ill.

DUMP CARS.

See CARS.

DYNAMITE.

See BLASTING MATERIALS.

ELECTRIC MOTORS.

See MOTORS.

ELEVATORS.

Otis Bros. & Co., 38 Park Row, New York City.
Morse, Williams & Co., Philadelphia, Pa.; 19 Pearl St., Boston, Mass.; Builders' Exchange, Baltimore, Md.
M. J. O'Donnell & Co., Cleveland, Ohio.
Winslow Elevator Co., Chicago, Ill.

EMERY-WHEELS.

Cutter, Wood & Stevens, 131 Pearl St., Boston, Mass.
Dickerman Emery Wheel and Machine Co., Bridgeport, Conn.
Manhattan Rubber Mfg. Co., 64 Cortlandt St., N. Y. City.
Pennsylvania Machine Co., Philadelphia, Pa.
Tanite Co., Stroudsburg, Pa.
Sterling Emery Wheel Works, Tiffin, Ohio.

ENGINES, GAS.

Gas Engine and Power Co., Morris Dock, N. Y. City.
Otto Gas Engine Works, Philadelphia, Pa.
Springfield Gas Engine Co., Springfield, Ohio.
Buckeye Mfg. Co., Anderson, Ind.
Van Dusen Gas and Gasoline Engine Co., Cincinnati, Ohio.
Carson & Slaysman, Baltimore, Md.
Weber Gas and Gasoline Engine Co., Kansas City, Mo.

ENGINES, HOISTING.

J. S. Mundy, 218 Congress St., Boston, Mass.; Newark, N. J.; 744 Market St., Philadelphia, Pa.; 117 Water St., Pittsburg, Pa.; 249 S. Jefferson St., Chicago, Ill.; Fourth and Wakauta Sts., St. Paul, Minn.; 715 N. Second St., St. Louis Mo.; 39 Magazine St., New Orleans, La.; 34 Fremont St., San Francisco, Cal.; 85 Front St., Portland, Ore.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y. City.
Contractors' Plant Mfg. Co., 129 Erie St., Buffalo, N. Y.
Lidgerwood Co., 96 Liberty St., N. Y. City.
Williamson Bros., Richmond & York Sts., Philadelphia, Pa.
Brown Hoisting and Conveying Machine Co., Cleveland, Ohio.
Thos. Carlin's Sons, Allegheny, Pa.
M. C. Bullock Mfg. Co., Chicago, Ill.
Sullivan Machinery Co., Chicago, Ill.
Walker Mfg. Co., Cleveland, Ohio.
Moore Mfg. Co., Milwaukee, Wis.

ENGINES, MARINE.

Atlantic Works, E. Boston, Mass.
Shipman Engine Co., Boston, Mass.
King Iron Works, Buffalo, N. Y.
Globe Iron Works, Cleveland, Ohio.
Cleveland Ship-building Co., Cleveland, Ohio.
S. F. Hodge & Co., Detroit, Mich.
Frontier Iron Works, Detroit, Mich.

ENGINES, PUMPING.

See PUMPING MACHINERY.

ENGINES, STATIONARY.

B. F. Sturtevant Co., Boston, Mass.
Ball & Wood, 15 Cortlandt St., N. Y. City.
Pennsylvania Machine Co., Philadelphia, Pa.
Southwark Foundry and Machine Co., Philadelphia, Pa.
Wm. A. Harris Steam Engine Co., Providence, R. I.
Fischer Foundry and Machine Co., Pittsburg, Pa.
Westinghouse Machine Co., Liberty Ave., Pittsburg, Pa.
King Iron Works, Buffalo, N. Y.
Chase Machine Co., Cleveland, Ohio.
Buckeye Engine Co., Salem, Ohio.
Fraser & Chalmers, Fulton and Union Sts., Chicago, Ill.; Denver, Colo.
M. C. Bullock, Chicago, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
Robt. Poole & Son Co., Baltimore, Md.
Smith-Courtney Co., Richmond, Va.
Valk & Murdock, Charleston, S. C.
Truxell & Dunmeyer, Chattanooga, Tenn.
Risdon Iron Works, San Francisco, Cal.

ENGINE SUPPLIES.

Nightingale & Childs, 134 Pearl St., Boston, Mass.
Robt. A. Keasby, 54 Warren St., N. Y. City.
Macan Co., 1420 Callowhill St., Philadelphia, Pa.
Keasby, Mattison & Co., 114 W. Second St., Cincinnati, Ohio; 117 Water St., Cleveland, Ohio.
Walch & Wyeth, 208 Lake St., Chicago, Ill.
F. Sprinkman, 133 Sycamore St., Milwaukee, Wis.
F. Bocler, 108 Walnut St., St. Louis, Mo.
S. P. Conklin, 20 E. Atwater St., Detroit, Mich.
Arthur L. Otto, 19 S. Third St., Minneapolis, Minn.
Wallace & Bro., 432 E. Pratt St., Baltimore, Md.
Delbert Engineering Co., New Orleans, La.
Symmes & Co., 162 Front St., Memphis, Tenn.
J. H. Stoner & Co., Kansas City, Mo.
C. W. Badgeley, Eighteenth and Market Sts., Denver, Colo.
De Solla & Deussing, 2 California St., San Francisco, Cal.
Risdon Iron Works, San Francisco, Cal.

ENGRAVERS.

Jas. Conant & Co., 3 Franklin St., Boston, Mass.
A. Mugford, Hartford, Conn.
Moss Engraving Co., 535 Pearl St., N. Y. City.
Stevens & Morris, 20 College Pl., N. Y. City.
Photo-Engraving Co., 403 Arcade, Cleveland, Ohio.
Baltimore Engraving Co., Baltimore, Md.
J. C. Irvine & Co., 339 Kearney St., San Francisco, Cal.

EXCAVATORS.

See DITCHING MACHINES.

FEED-WATER HEATERS AND PURIFIERS.

I. B. Davis & Son, Hartford, Conn.
National Pipe Bending Co., New Haven, Conn.
Whitlock Coil Pipe Co., Elmwood, Conn.
Wheeler Condenser and Engineering Co., 39–41 Cortlandt St., N. Y. City.
Goubert Mfg. Co., 14–16 Church St., N. Y. City.
Pennsylvania Machine Co., Philadelphia, Pa.
Harrison Safety Boiler Works, Philadelphia, Pa.
Webster, Warren & Co., Camden, N. J.
Robt. Wetherill & Co., Chester, Pa.
Fraser & Chalmers, Chicago, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
Adrian R. Smith, 315 California St., San Francisco, Cal.

FILES.

F. W. Moss, 80 John St., N. Y. City.
Troy File Works, Troy, N. Y.
G. & H. Barnett, 41–43 Richmond St., Phila., Pa.
McCaffrey File Co., Philadelphia, Pa.
Nicholson File Co., Providence, R. I.
Arcade File Works, Anderson, Ind.

FIRE-BRICKS.

See BRICKS.

FIRE-PROOF BUILDING MATERIALS.

See BUILDING MATERIALS.

FLEXIBLE SHAFTS.

See SHAFTING.

FILTERS.

Cumberland Mfg. Co., Boston, Mass.
Morison Jewell Filtration Co., N. Y. City.
Continental Filter Co., 44 Wall St., N. Y. City.
Pittsburg Filter Co., Allegheny City, Pa.

FLAGS.

Horstmann & Co., Cherry St., Philadelphia, Pa.

FLY-WHEELS.

Walker Mfg. Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
Robt. Poole & Son Co., Baltimore, Md.

FORGES.

B. F. Sturtevant Co., Boston, Mass.
Buffalo Forge Co., Buffalo, N. Y.
Pennsylvania Machine Co., Philadelphia, Pa.
Champion Blower and Forge Co., Lancaster, Pa.
Foos Mfg. Co., Springfield, Ohio.

FORGINGS, IRON AND STEEL.

Belden Machine Co., New Haven, Conn.
Wyman & Gordon, Worcester, Mass.
Delaney Forge and Iron Works, Buffalo, N. Y.
U. S. Projectile Co., Brooklyn, N. Y.
Cambria Co., Johnstown, Pa.
Scranton Forging Co., Scranton, Pa.
Bethlehem Iron Co., S. Bethlehem, Pa.
Sternbergh & Son, Reading, Pa.
Toledo Machine & Tool Co., Toledo, Ohio.

FOUNDRIES.

See CASTINGS.

FRICTION CLUTCHES.

See CLUTCHES.

FROGS AND SWITCHES.

New York Frog and Switch Co., Hoboken, N. J.
Ramapo Iron Works, Hillburn, N. Y.
Pennsylvania Steel Co., 208 S. Fourth St., Philadelphia, Pa.
National Switch & Signal Co., Easton, Pa.
Carlisle Mfg. Co., Carlisle, Pa.
Pettibone, Mulliken & Co., "The Rookery," Chicago, Ill.
Elliot Frog & Switch Co., East St. Louis, Ill.

FURNACES.

Continental Iron Works, Brooklyn, N. Y.
Julian Kennedy, Pittsburg, Pa.
Griffith & Wedge Co., Zanesville, Ohio.
Fraser & Chalmers, Chicago, Ill.
Byram & Co., Detroit, Mich.
Richardson & Boynton Co., 234 Water St., N. Y. City; 84 Lake St., Chicago, Ill.

GAUGES, STEAM.

Crosby Steam Gage and Valve Co., Boston, Mass.; N. Y. City; Chicago, Ill.
Bristol Co., Waterbury, Conn.
Standard Thermometer Co., Peabody, Mass.
Star Brass Mfg. Co., Boston, Mass.
Hohmann & Maurer Mfg. Co., Brooklyn, N. Y.

GAUGES, WATER.

Reliance Gage Co., Cleveland, Ohio.

GATE VALVES.

See VALVES.

GEARING.

Boston Gear Works, Boston, Mass.
General Electric Co., 44 Broad St., N. Y. City.
Stow Flexible Shaft Co., Philadelphia, Pa.
Walker Mfg. Co., Cleveland, Ohio.
Dayton Globe Iron Works, Dayton, Ohio.
Edw. P. Allis Co., Milwaukee, Wis.
Robt. Poole & Son Co., Baltimore, Md.

GRAPHITE.

Joseph Dixon Crucible Co., Jersey City, N. J.
Detroit Graphite and Mfg. Co., Detroit, Mich.

GRATES AND HEARTHS.

Edw. A. Jackson & Bros., 50 Beekman St., N. Y. City.
Sam'l H. French & Co., Philadelphia, Pa.
Vulcan Iron Works, Toledo, Ohio.

GRIPS, CABLE.

Robt. Wetherill & Co., Chester, Pa.
Walker Mfg. Co., Cleveland, Ohio.
Robt. Poole & Son Co., Baltimore, Md.

HAND CARS.

See CARS.

HARDWARE.

Adams & Isley, 150 Tremont St., Boston, Mass.
Chas. Parker Co., Meriden, Conn.
Yale & Towne Mfg. Co., Stamford, Conn.
Covert Mfg. Co., West Troy, N. Y.
Miller Falls Co., 93 Reade St., N. Y. City.
Union Mfg. Co., 103 Chambers St., N. Y. City.
Supplee Hardware Co., Philadelphia, Pa.
Biddle Hardware Co., 507 Commerce St., Philadelphia, Pa.
American Iron and Steel Works, Pittsburg, Pa.
G. Cluthe, Cincinnati, Ohio.
W. Bingham Co., Cleveland, Ohio.
Chicago Hardware Mfg. Co., 29 Erie St., Chicago, Ill.
Empire Wire Nail Co., Detroit, Mich.
Etler & Enger Mfg. Co., St. Louis, Mo.
Simmons Hardware Co., St. Louis, Mo.
J. Parker Hinds, Baltimore, Md.
Russell & Minnegerode, Richmond, Va.
T. M. Clarke & Co., Atlanta, Ga.
H. Oething Hardware Co., New Orleans, La.
Prest Hardware and Furnace Co., Kansas City, Mo.
Bliss Cotton Hardware Co., Denver, Colo.
California Hardware Co., San Francisco, Cal.
Spokane Hardware Co., Spokane, Wash.

HEATING APPARATUS.

Gurney Heating and Mfg. Co., Boston, Mass.
Hart & Krouse, Utica, N. Y.
H. B. Smith Co., 133–137 Centre St., N. Y. City.
Boynton Furnace Co., 207 Water St., N. Y. City.
Gorton & Lidgerwood Co., 96 Liberty St., N. Y. City.
Buffalo Forge Co., Buffalo, N. Y.
Onderdonk Heating and Ventilating Co., 520 Commerce St., Philadelphia, Pa.

American Radiator Co., 111–113 Lake St., Chicago, Ill.; 92 Centre St., N. Y. City; 44 Oliver St., Boston, Mass.; 1104 N. Levee St., St. Louis, Mo.; 330 First St., Minneapolis, Minn.
U. S. Heater Co., Detroit, Mich.
St. Louis Radiator Co., Union Trust Co. Bldg., St. Louis, Mo.
Crook, Horner & Co., Baltimore, Md.

HOISTING MACHINERY.

Carson Trench Machine Co., Boston, Mass.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y. City.
J. H. Lancaster, 39–41 Cortlandt St., N. Y. City.
Earle C. Bacon, 26 Cortlandt St., N. Y. City.
W. A. Crooke & Bros. Co., Newark, N. J.
J. S. Mundy, Newark, N. J.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Moore Mfg. Co., Buffalo, N. Y.
American Ship Windlass Co., Providence, R. I.
Thos. Carlin's Sons, Allegheny, Pa.
Excelsior Iron Works, 100 N. Clinton St., Chicago Ill.
Walker Mfg. Co., Cleveland, Ohio.
Brown Hoisting and Conveying Machine Co., Cleveland, Ohio.
M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
Moore Mfg. and Foundry Co., Milwaukee, Wis.
American Hoist and Derrick Co., St. Paul, Minn.; Carew Bldg., Cincinnati, Ohio.
Ryan McDonald Co., Baltimore, Md.
Truxell & Dunmeyer, Chattanooga, Tenn.
Risdon Iron Works, San Francisco, Cal.
See J. S. Mundy, under "ENGINES, HOISTING."

HOSE.

Boston Belting Co., 256–60 Devonshire St., Boston, Mass.; 100 Chambers St., N. Y. City; 14 N. Fourth St., Philadelphia, Pa.; 150 Water St., Cleveland, Ohio; 161–165 Pearl St., Cincinnati, Ohio; 109 Madison St., Chicago, Ill.; 380 E. Water St., Milwaukee, Wis.; 248–52 Fourth St., St. Paul, Minn.; 9th St. and Washington Ave., St. Louis, Mo.; 26 Light St., Baltimore, Md.; 410–12 W. 5th St., Kansas City, Mo.; 24 Fremont St., San Francisco; 14–16 Front St., Portland, Ore.
Crosby Steam Gauge and Valve Co., Boston, Mass.
New York Belting and Packing Co., N. Y. City.
Peerless Rubber Mfg. Co., 15 Warren St., N. Y. City.

HYDRANTS AND VALVES.

Peet Valve Co., Boston, Mass.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Holyoke Hydrant and Iron Works, Holyoke, Mass.
John Fox, 160 Broadway, N. Y. City.
John McLean, 298 Monroe St., N. Y. City.
Pancoast & Rogers, 15 Gold St., N. Y. City.
Ross Valve Co., Troy, N. Y.
Ludlow Valve Mfg. Co., Troy, N. Y.
Eddy Valve Co., Waterford, N. Y.
Holly Mfg. Co., Lockport, N. Y.
R. D. Wood & Co., 400 Chestnut St., Philadelphia, Pa.
Tamaqua Mfg. Co., Tamaqua, Pa.
Richard Beaumont, Kankakee, Ill.
Michigan Brass and Iron Works, Detroit, Mich.

HYDRAULIC MACHINERY.

U. S. Projectile Co., Brooklyn, N. Y.
Watson & Stillman, 204–210 43d St., N. Y. City.
Richard Dudgeon, 24 Columbia St., N. Y. City.
Wm. H. Wood, Media, Pa.
See also JACKS, HYDRAULIC.

INDICATORS AND INJECTORS.

Crosby Steam Gauge and Valve Co., Boston, Mass.
Hine & Robertson Indicator Co., Cortlandt St., N. Y. City.
Thompson Hydraulic Co., Nassau and Beekman Sts., N. Y. City.
Eynon-Evans Mfg. Co., Philadelphia, Pa.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Detroit, Mich.
Ahrens & Ott Mfg. Co., Louisville, Ky.
Milner & Kettig Co., Birmingham, Ala.

INSTRUMENTS, ENGINEERING AND SURVEYING.

Buff & Berger, Boston, Mass.
E. L. Deane, Holyoke, Mass.
Keuffel & Esser Co., 127 Fulton St., N. Y. City.
Brandis Sons Co., Brooklyn, N. Y.
W. & L. E. Gurley, Troy, N. Y.
Thos. Alteneder, 355 N. Tenth St., Philadelphia, Pa.
Ball-Ball Co., Philadelphia, Pa.
Heller & Brightly, Philadelphia, Pa.
Queen & Co., Philadelphia, Pa.
Young & Sons, 43 N. 7th St., Philadelphia, Pa.
Hermann Pfister, 176–80 Plum St., Cincinnati, Ohio.
Seelig & Kandler, 194 Madison St., Chicago, Ill.
Kuhlo & Ellerbe, St. Paul, Minn.
Mahn & Co., St. Louis, Mo.
A. S. Alloe & Co., 415 N. Broadway, St. Louis, Mo.
Fauth & Co., 132–34 Maryland Ave., S. W., Washington, D. C.,

IRON MANUFACTURERS AND DEALERS.

Gustaf Lundburg, Boston, Mass.
Abbott Wheelock & Co., New York and Boston.
Ogden & Wallace, 577–83 Greenwich St., N. Y. City.
C. K. Barnes, Philadelphia, Pa.
Nicoll, Wheeler & Co., Philadelphia, Pa.
Adolph Butze, St. Louis, Mo.

IRON CASTINGS.

See CASTINGS.

IRON ROOFING.

See ROOFING.

JACKS, HYDRAULIC.

Watson & Stillman, 204–210 E. 43d St., N. Y. City.
Richard Dudgeon, 24 Columbia St., N. Y. City.
J. F. McCoy & Co., 26 Warren St., N. Y. City.
Dienelt & Eisenhardt, Philadelphia, Pa.
Riehle Bros. Testing-machine Co., Philadelphia, Pa.
McSherry Mfg. Co., Middleton, Ohio.
G. B. Carpenter & Co., Chicago, Ill.

JOURNAL BEARINGS.

See METALS, ANTI-FRICTION.

LABOR, ITALIAN.

Donato Cuozzo, 386 Broome St., N. Y. City.
Pasquale Martino, Brooklyn, N. Y.

LATHES.

Draper Machine Tool Co., Worcester, Mass.
Fitchburg Machine Works, Fitchburg, Mass.
Prentiss Tool & Supply Co., 115 Liberty St., N. Y. City.
Manning, Maxwell & Moore, 111 Liberty St., N. Y. City.
E. Harrington, Son & Co., Philadelphia, Pa.
Pennsylvania Machine Co., Philadelphia, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Beaman & Smith, Providence, R. I.
Dietz, Schumacher & Co., Cincinnati, Ohio.
Sebastian Lathe Co., Cincinnati, Ohio.
Springfield Machine Tool Co., Springfield, Ohio.
See also MACHINERY.

LAUNCHES, ELECTRIC AND NAPHTHA.

Gas Engine and Power Co., Morris Heights, N. Y. City.
Cleveland Ship Building Co., Cleveland, Ohio.
General Electric Launch Co., 44 Broad St., Chicago, Ill.
Detroit Boat Works, Detroit, Mich.
Caldwell Bros., Tacoma, Washington.

LIFE-SAVING APPARATUS.

Armstrong Cork Co., New York, Pittsburg, Chicago, St. Louis.
D. Kahn Weiler, 437 Pearl St., N. Y. City.
Detroit Sheet Metal & Brass Works, 64–72 Orleans St., Detroit, Mich.

LOCOMOTIVES.

Brooks Locomotive Co., Dunkirk, N. Y.
Schenectady Locomotive Works, Schenectady, N. Y.
Baldwin Locomotive Works, Philadelphia, Pa.
Rogers Locomotive Works, Patterson, N. J.
Pittsburg Locomotive Works, Pittsburg, Pa.
Richmond Locomotive & Machine Works, Richmond, Va.
H. A. Keefer, Kansas City, Mo.

LUBRICANTS.

Joseph Dixon Crucible Co., Jersey City, N. J.
Dreher Mfg. Co., 249 Front St., N. Y. City.
Signal Oil Works, Franklin, Pa.
Lunkenheimer Co., Cincinnati, Ohio; 51 Dey St. N. Y. City.
Allerton Lubricant Co., Chicago, Ill.

LUBRICATORS.

Wilmot & Hobbs Mfg. Co., Bridgeport, Conn.
Bloomsburg Mfg. Co., Bloomsburg, Pa.
Sherwood Mfg. Co., Buffalo, N. Y.
Lunkenheimer Co., Cincinnati, Ohio.
Bumann Mfg. Co., Litchfield, Ill.

LUMBER.

E. G. Pond, Boston, Mass.
Vanderbilt & Hopkins, N. Y. City.
Lehigh Valley Creosoting Co., Jersey City, N. J.
Buffalo Lumber Co., 209 Girard Building, Philadelphia, Pa.
J. M. Murdock & Bro., Johnstown, Pa.
Wm. Anderson & Co., Pittsburg, Pa.
Baldridge & Hogan, Cincinnati, Ohio.
E. C. Atkins, Minneapolis, Minn.
C. A. Beck, Milwaukee, Wis.
St. Louis Lumber Co., St. Louis, Mo.
Wm. Berry & Co., Baltimore, Md.
W. W. Almar & Co., Savannah, Geo.
J. H. Anthony, Memphis, Tenn.
Otis Mfg. Co., New Orleans, La.
Badger Lumber Co., Kansas City, Mo.
Atlas Lumber Co., Denver, Col.
Allen & Higgins, San Francisco, Cal.
Tacoma Timber Co., Tacoma, Washington.

MACHINERY.

Hill, Clarke & Co., Boston, Mass.
American Tool & Machinery Co., Boston, Mass.
C. E. Bigelow, 45 Dey St., N. Y. City.
Manning, Maxwell & Moore, 111 Liberty St., N. Y. City.
Bement, Miles & Co., Philadelphia, Pa.
E. Harrington, Son & Co., Philadelphia, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Beaman & Smith, Providence, R. I.
Chas. H. Amidon, Buffalo, N. Y.
Buffalo Machine Co., Buffalo, N. Y.
Thos. Carlin's Sons, Allegheny, Pa.
Pittsburg Mfg. Co., Pittsburg, Pa.
Cordesman Machine Co., 20–30 Butler St., Cincinnati, Ohio.
Acme Machinery Co., Cleveland, Ohio.
Walker Mfg. Co., Cleveland, Ohio.
Armstrong Bros. Tool Co., Chicago, Ill.
Charles H. Besly & Co., Chicago, Ill.
Ball Pump & Supply Co., Minneapolis, Minn.
Reliance Machine Co., Minneapolis, Minn.
O. L. Packard Machinery Co., Milwaukee, Wis.
Bignall & Keely Mfg. Co., St. Louis, Mo.
Campbell & Zell Co., Essex and Burke Sts., Baltimore, Md.
Robt. Poole & Son Co., Baltimore, Md.
Ætna Iron Works, Norfolk, Va.
Richmond Locomotive & Machine Works, Richmond, Va.
Charleston Iron Works, Charleston, S. C.
Atlanta Machine Works, Atlanta, Ga.
L. L. Burdon, Louisville, Ky.
Kentucky Machine Works, Louisville, Ky.
Milburn Gin & Machine Co., Memphis, Tenn.
H. D. Coleman Machine Co., New Orleans, La.
C. A. Brackett & Co., Kansas City, Mo.
Kansas City Machinery and Supply Co., Kansas City, Mo.
Denver Machinery Co., Denver, Col.
Fremont Machine Works, San Francisco, Cal.
Portland Foundry and Machine Works, Portland, Ore.

MACHINE SCREWS.

Worcester Machine Screw Co., Worcester, Mass.
Harvey Hubbell, Bridgeport, Conn.
Rhode Island Tool Co., Providence, R. I.
Cincinnati Screw and Tap Co., Cincinnati, Ohio.
See also BOLTS, NUTS, AND WASHERS.

MACHINE TOOLS AND SUPPLIES.

MALLEABLE IRON CASTINGS.

See CASTINGS.
See MACHINERY.

MARBLE.

True Blue Marble Co., Rutland, Vt.
Davidson Sons' Marble Co., 11th Ave., N. Y. City.
Batterson & Eisele, 431 11th Ave., N. Y. City.
Southern Marble Co., Marble Hill, Pickens Co., Georgia.

METERS—GAS AND WATER.

Hersey Mfg. Co., S. Boston, Mass.
Metropolitan Meter Co., Boston, Mass.
Union Water Meter Co., Worcester, Mass.
Builders' Iron Foundry, Venturi Meters, Providence, R. I.
National Meter Co., 252 Broadway, N. Y. City.
Thompson Hydraulic Co., Nassau and Beekman Sts., N. Y. City.
Buffalo Meter Co., Buffalo, N. Y.
The Fuel Gas and Mfg. Co., Pittsburg, Pa.

METALS—ANTI-FRICTION.

Bridgeport Deoxidized Bronze and Metal Co., Bridgeport, Conn.
Magnolia Metal Co., 74 Cortlandt St., N. Y. City; Traders' Bldg., Chicago, Ill.
Brady Metal Co., 115 Broadway, N. Y. City.
Phosphor Bronze Smelting Co., Philadelphia, Pa.
Paul S. Reeves, Philadelphia, Pa.
Crown Smelting Co., Chester, Pa.
Damascus Bronze Co., Pittsburg, Pa.
Ed. Wertheim, 207–209 Lake St., Chicago, Ill.
T. Hiertz & Son, St. Louis, Mo.

METALLIC PACKING.

See PACKING.

MOTORS—ELECTRIC.

"C. & C." Electric Motor Co., 402–404 Greenwich St., N. Y. City; 88–92 S. Fifth Ave., N. Y. City.
General Electric Co., 44 Broad St., N. Y. City.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Walker Mfg. Co., Cleveland, Ohio.
Brush Electric Co., Cleveland, Ohio.
Siemans & Halske Electric Co., Chicago, Ill.

MOTORS—GAS AND WATER.

"C. & C." Electric Co., 402–404 Greenwich St., N. Y. City.
Daimler Gas Motor Co., Steinway, L. I.
Thos. H. Dallett & Co., Philadelphia, Pa.
Robt. Poole & Son Co., Baltimore, Md.

NAILS AND SPIKES.

Atlas Tack Corporation, Boston, Mass.
Borden & Lovell, 70 West St., N. Y. City.
Kilmer Mfg. Co., Newburgh, N. Y.
Atlas Tack Corporation, 31 Warren St., N. Y. City; 339 Market St., Philadelphia, Pa.; 193 Lake St., Chicago, Ill.; 14 W. German St., Baltimore, Md.; 408 Market St., San Francisco.
Baackes & Co., Pittsburg, Pa.
Pottstown Iron Co., Pottstown, Pa.
Riverside Iron Works, Wheeling, W. Va.
Grand Crossing Tack Co., Grand Crossing, Chicago, Ill.
Union Steel Co., St. Louis, Mo.
Old Dominion Nail and Iron Works, Richmond, Va.

See also HARDWARE.

NAUTICAL INSTRUMENTS.

T. S. & J. D. Negus, 140 Water St., New York City.
Frank Morrison, 161 River St., Cleveland, Ohio.

NUTS.

See BOLTS.

NUT LOCKS.

Young Nut Lock Co., 15 Broadway, N. Y. City.
Eureka Nut Lock Co., Pittsburg, Pa.
National Elastic Nut Co., Milwaukee, Wis.

OILS.

See LUBRICANTS.

OIL CUPS.

See LUBRICATORS.

PACKING.

American Steam Packing Co., 51 Kilby St., Boston, Mass.
Hine & Robertson, 66 Cortlandt St., N. Y. City.
L. Katzenstein, 357 West St., N. Y. City.
New York Belting and Packing Co., N. Y. City.
Peerless Rubber Mfg. Co., 15 Warren St., N. Y. City.
Sherwood Mfg. Co., Buffalo, N. Y.
Quaker City Rubber Works, Philadelphia, Pa.
U. S. Metallic Packing Co., 435 N. Broad St., Philadelphia, Pa.
Ed. Wertheim, 207–209 Lake St., Chicago, Ill.
Crandall Packing Co., 51 S. Canal St., Chicago, Ill.; 136 Liberty St., N. Y. City.
Robt. Morrison, St. Louis, Mo.

See Boston Belting Co. under "HOSE," and also ENGINE SUPPLIES.

PAINTS AND OILS.

National Lead and Oil Co., N. Y. City.
John Lucas & Co., Philadelphia, Pa.
Murphy Bros., Pittsburg, Pa.
Iron-Clad Paint Co., 75–77 Central Way, Cleveland, Ohio.
F. W. Devoe & C. T. Reynolds Co., 176 Randolph St., Chicago, Ill.
Detroit Graphite Mfg. Co., 542 River St., Detroit, Mich.
Chattanooga Paint Co., Chattanooga, Tenn.
Paraffine Paint Co., 116 Battery St., San Francisco, Cal.; Portland, Ore.

PAVING.

Booth Bros. & Hurricane Island Granite Co., 60 Bank St., N. Y. City.
W. H. Knowlton, "Times" B'ld'g, N. Y. City.
Lehigh Valley Creosoting Co. (Wooden Blocks), Jersey City, N. J.
Park Fire Clay Co. (Paving Brick), Pittsburg, Pa.

See also ASPHALT and STONE.

PHOTOGRAHPHIC SUPPLIES.

Eastman Kodak Co., Rochester, N. Y.
Rochester Optical Co., Rochester, N. Y.
Queen & Co., Philadelphia, Pa.

PILE-DRIVING MACHINERY.

J. M. Mays & Co., 209 Walnut St., Philadelphia, Pa.
Monongahela and Western Co., Pittsburg, Pa.
Toledo Foundry and Machine Co., Toledo, Ohio.
Vulcan Iron Works Co., Cleveland, Ohio.
Vulcan Iron Works, Chicago, Ill.
Industrial Works, Bay City, Mich.
R. J. & A. B. Cram, Detroit, Mich.
American Hoist and Derrick Co., St. Paul, Minn.

See also J. S. Mundy, under "ENGINES, HOISTING."

PIPE, CAST IRON.

Fred. A. Houdlette & Son, Boston, Mass.
Pancoast & Rogers, 28 Platt St., N. Y. City.
R. D. Wood & Co., 400 Chestnut St., Philadelphia, Pa.
Buffalo Pipe Works, Buffalo, N. Y.
Lake Shore Foundry Co., Cleveland, Ohio.
Radford Pipe & Foundry Co., Cincinnati, Ohio.
Addyston Pipe & Steel Co., Cincinnati, Ohio.
Chattanooga Foundry & Pipe Co., Chattanooga, Tenn.
N. Clark & Sons, 17 Spear St., San Francisco, Cal.

See also CASTINGS.

PIPE, FIRE-CLAY.

John H. Jackson, Albany, N. Y.
Syracuse Stone Ware Agency, Syracuse, N. Y.
Sharon Clay Mfg. Co., Sharon, Pa.
Park Fire Clay Co., Pittsburg, Pa.
Columbus Sewer Pipe Co., Columbus, Ohio.
White Hall Fire Clay Works, White Hall, Ill.
Dennis Long & Co., Louisville, Ky.
Lookout Sewer Pipe Co., Chattanooga, Tenn.

PIPE, LEAD-LINED.

Lead-Lined Pipe Co., Wakefield, Mass.
Pancoast & Rogers, 28 Platt St., N. Y. City.
Morris, Tasker & Co., Philadelphia, Pa.

PIPE, WROUGHT-IRON.

Sumner & Goodwin, 15 Oliver St., Boston, Mass.
F. B. Hawkins & Co., Boston and N. Y. City.
John Fox, 160 Broadway, N. Y. City.
Morris, Tasker & Co., Philadelphia, Pa.
National Tube Works Co., McKeesport, Pa.
Robt. E. Hills, 57–59 N. Wells St., Chicago, Ill.
L. M. Rumsey & Co., St. Louis, Mo.
Chattanooga Foundry and Pipe Works, Chattanooga, Tenn.

PIPE FITTINGS AND TOOLS.

See PLUMBING.

PLANES.

See TOOLS.

PLUMPING SUPPLIES.

Gilchrist & Gorhan, 207 Congress St., Boston, Mass.
J. L. Mott Iron Works, 84–90 Beekman St., N. Y.

City; 332–334 Boylston St., Boston, Mass; 311–313 Wabash Ave., Chicago, Ill.; Wainwright Bldg., St. Louis, Mo.; Flood Bldg., San Francisco, Cal.
Steel Bath Mfg. Co., Detroit, Mich.
Haines, Jones & Cadbury, 1136 Ridge Ave., Philadelphia, Pa.
Standard Mfg. Co., Box 1454, Pittsburg, Pa.
John Douglas Co., 162–164 Poplar St., Cincinnati, Ohio.
L. Wolf Mfg. Co., 93 W. Lake St., Chicago, Ill.; Minneapolis, and Denver.
Jas. Robertson Mfg. Co., Baltimore, Md.
Ahrens & Ott, Louisville, Ky.
Milner & Kettig, Birmingham, Ala.
T. Wortley Kansas City, Mo.

PNEUMATIC FOUNDATIONS.

Anderson & Barr, 240 11th St., Jersey City, N. J.
Sooysmith & Co., 2 Nassau St., N. Y. City.

POWER HAMMERS AND PUNCHES.

Butts & Ordway, Boston, Mass.
Watson & Stillman, 204 E. 43d St., N. Y. City.
Bradley Co., Syracuse, N. Y.
Dienelt & Eisenhardt, Philadelphia, Pa.
Walker Mfg. Co., Cleveland, Ohio.
J. A. Crosby & Co., Chicago, Ill.

POWER TRANSMITTING MACHINERY.

See TRANSMISSION MACHINERY.

PRESSURE REGULATORS.

Mason Regulator Co., Boston, Mass.
Standard Thermometer Co., Peabody, Mass.
D'Este & Seeley Co., 29–33 Haverhill St., Boston, Mass.; 109 Liberty St., N. Y. City; 218 Lake St., Chicago, Ill.
J. H. Dousman, Milwaukee, Wis.

PROPELLERS.

G. Douglas Petrie, 39–41 Cortlandt St., N. Y. City.
King Iron Works, Buffalo, N. Y.
Cleveland Ship-building Co., Cleveland, Ohio.
Globe Iron Works Co., Cleveland, Ohio.
McKinnon Mfg. Co., Bay City, Mich.

PULLEYS AND SHAFTING.

Boston Gear Works, Boston, Mass.
Cook & Co., 163 Washington St., N. Y. City.
Volney W. Mason & Co., Providence, R. I.
Moore & White Co., Philadelphia, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.
Walker Mfg. Co., Cleveland, Ohio.
G. B. Carpenter & Co., Chicago, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
Robt. Poole & Son Co., Baltimore, Md.
Talbott & Sons, Richmond, Va.
Truxell & Dunmeyer, Chattanooga, Tenn.

PUMPS AND PUMPING MACHINERY.

Deane Steam Pump Co., Holyoke, Mass.
Perrin Seamans & Co., 57 Oliver St., Boston, Mass.
Geo. F. Blake Mfg. Co., 185 Devonshire St., Boston, Mass.; 95–97 Liberty St., N. Y. City.
Henry R. Worthington, 86–88 Liberty St., N. Y. City.
Pulsometer Steam Pump Co., 120 Liberty St., N. Y. City.
Davidson Steam Pump Co., 41–51 Keap St., Brooklyn, N. Y.; 51 Oliver St., Boston, Mass.
Joseph Edwards & Co., 412–416 Water St., N. Y. City.
Gould Mfg. Co., 60 Barclay St., N. Y. City.
R. D. Wood & Co., Philadelphia, Pa.
Walker Mfg. Co., Cleveland, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Fraser & Chalmers, Chicago, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
Cook Well Co., St. Louis, Mo.
Louisville Steam Pump Co., Louisville, Ky.
Lookout Steam Boiler Works, Chattanooga, Tenn.
Cameron & Barkley Co., Charleston, S. C.
Henry R. Worthington, 1762 Larimer St., Denver, Col.
Union Iron Works; First and Mission Sts., San Francisco, Cal.
Holly Pumping Co., 315 12th St., Portland, Ore.

QUARRYING MACHINERY.

See DRILLING MACHINES.

RAILS AND RAIL JOINTS.

New York Equipment Co., 15 Wall St., N. Y. City.
Robinson & Orr, 419 Wood St., Pittsburg, Pa.
Pettibone, Mulliken & Co., 401 "The Rookery," Chicago, Ill.
M. C. & S. S. Niles, Chicago, Ill.
Heath Rail Joint Co., Minneapolis, Minn.
Tredegar Iron Works, Richmond, Va.

RAILWAY SUPPLIES.

Sylvestor & Co., Boston, Mass.
DeGrauw, Aymar & Co., 34, 35 South St., N. Y. City.
New Jersey Car Spring and Rubber Co., Jersey City, N. J.
W. T. Barutio & Co., Philadelphia, Pa.
Robinson & Orr, 419 Wood St., Pittsburgh, Pa.
Carlisle Mfg. Co., Carlisle, Pa.
Drexel R'way Supply Co., "The Rookery," Chicago, Ill.
A. S. Males & Co., Cincinnati, Ohio.
Detroit R'way Supply Co., Detroit, Mich.
M. M. Buck & Co., 207 N. 3d St., St. Louis, Mo.
Morton Reed & Co., Baltimore, Md.
Southern R'way Supply Co., Richmond, Va.
James & Co., Chattanooga, Tenn.
New Orleans R'way and Mill Supply Co., New Orleans, La.

RIVETS.

Blake & Johnson, Waterbury, Conn.
Burden Iron Co., Troy, N. Y.
Dover Iron Co., Dover, N. J.
Pennsylvania Bolt and Nut Co., Lebanon, Pa.
J. H. Sternbergh & Son, Reading, Pa.

RIVETING MACHINES.

John Adt & Sons, New Haven, Conn.

ROAD-MAKING MACHINERY.

Harrisburgh Foundry and Machine Works, Harrisburgh, Pa.
Addyston Pipe and Steel Co., Cincinnati, Ohio.
O. S. Kelly Co., Springfield, Ohio.
Vulcan Iron Works, Toledo, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
F. G. Austin Mfg. Co., Carpenter St. and Carroll Ave., Chicago, Ill.

ROAD ROLLERS.

Pioneer Iron Works, Brooklyn, N. Y.
Harrisburgh Foundry and Machine Works, Harrisburgh, Pa.
Erie Machine Shop, Erie, Pa.
Union Iron and Foundry Co., 1458 S. Second St., St. Louis, Mo.
H. E. Baldwin, Perwin Bldg., Cincinnati, Ohio.
Wallace Stebbins, 111 E. German St., Baltimore, Md.

ROAD SPRINKLERS.

Haydenville Mfg. Co., 73 Beekman St., N. Y. City.
Studebaker Bros., South Bend, Ind.
Bailey Libbey Co., Charleston, S. C.

ROAD SWEEPERS.

Lewis & Fowler Mfg. Co., 28 Sanford St., Brooklyn, N. Y.

ROCK DRILLS.

See DRILLS.

ROCK AND ORE CRUSHERS.

See CRUSHING MACHINERY.

ROOFING.

Berlin Iron Bridge Co., E. Berlin, Conn.
Warren Chemical & Mfg. Co., 27 Fulton St., N. Y. City.
Continental Iron Works, Brooklyn, N. Y.
Merchant & Co., 517 Arch St., Philadelphia, Pa.
Canton Steel Roofing Co., Canton, Ohio.
Jas. A. Miller & Bro., 129–131 S. Clinton St., Chicago, Ill.

ROPE, HEMPEN.

De Grauw, Aymar & Co., 34 and 35 South St., N. Y. City.
Lawrence Cordage Works, 46 South St., N. Y. City.
Howard H. Baker & Co., 18–26 Terrace. Buffalo, N. Y.
George B. Carpenter & Co., 207 and 209 S. Water St., Chicago, Ill.
J. L. Lindsay. Richmond, Va.

ROPE, WIRE.

See CABLE.

ROPE TRANSMISSION.

See TRANSMISSION MACHINERY.

RUBBER GOODS.

Newton Rubber Works, Boston, Mass.
Spinney, Virtue & Co., Lynn, Mass.
Manhattan Rubber Mfg. Co., 64 Cortlandt St., N. Y. City.
New York Belting and Packing Co., New York City.
Peerless Rubber Mfg. Co., 15 Warren St., New York City.
Home Rubber Co., Trenton, N. J.

See Boston Belting Co., under "HOSE."

RULES AND MEASURING TAPES.

Stephens & Co., Riverton, Conn.
Stanley Rule and Level Co., 29 Chambers St., N. Y. City.
Geo. M. Eddy & Co., 345–353 Classon Ave., Brooklyn, N. Y.
Geo. B. Carpenter & Co., 297–209 S. Water St., Chicago, Ill.

See also INSTRUMENTS—ENGINEERING and SURVEYING.

RUST-PROOF IRON.

G. W. Gesner, 15 State St.. N. Y. City.

SAFETY-VALVES.

See VALVES.

SAWS.

Simonds Mfg. Co., Fitchburg, Mass.
National Saw Co., Newark, N J.
Henry Disston & Sons, Philadelphia, Pa.
E. C. Atkins & Co., Indianapolis, Ind.; Minneapolis, Minn.; Memphis, Tenn.; Chattanooga, Tenn.
Simonds Saw Co., 21 S. Canal St., Chicago, Ill.; 215 Magazine St., New Orleans, La.; San Francisco, Cal.; Portland, Ore.

SCALES.

John Chatillon & Sons, 85–93 Cliff St., N. Y. City.
Buffalo Scale Co., Buffalo, N. Y.
Fairbanks Scale Co., Broadway, N. Y.

SCRAPERS.

American Road Machine Co., Kennett Square, Pa.

SCREWS.

Blake & Johnson, Waterbury, Conn.
Worcester Machine Screw Co., Worcester, Mass.
Henry B. Newhall Co., 105 Chambers St., N. Y. City.
Wm. H. Haskell Co., Pawtucket, R. I.
F. S. Miles, 205 Quarry St., Philadelphia, Pa.
Cincinnati Screw and Tap Co., Cincinnati, Ohio.

See also HARDWARE.

SEWAGE-PUMPING MACHINERY.

Henry R. Worthington, 86 Liberty St., N. Y. City.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.

See also PUMPING MACHINERY.

SEWERS, JOINTLESS.

Monolithic Drain and Conduit Co., 5 Beekman St., N. Y. City.

SHAFTING.

See PULLEYS.

SHEET-PILING.

Wakefield Sheet Piling Co., Monadnock Bldg., Chicago, Ill.

SHIPBUILDING.

Arthur D. Story, Essex, Mass.
Elmer A. Ely, Middleton, Conn.
A. M. Gamage & Co., S. Bristol Me.
C. V. Minott, Phillipsburg, Me.
Farr & James, Essex, Mass.
Portland Ship-building Co., Portland, Me.
Fillmore A. Baker, Patchogue, L. I.
Isaac Combs, Camden, Me.
E. S. Crosby, Bath, Me.
Bath Iron Works, Bath, Me.
McDonald & Brown, Belfast, Me.
New England Co., Bath, Me.
Atlantic Works, E. Boston, Mass.
Robt. Palmer & Son Co., Norwalk, Conn.
Geo. Lawley & Son Co., S. Boston, Mass.
Crescent Ship Yard, Elizabeth, N. J.
Bell's Steam Engine Works, Buffalo, N. Y.
J. H. Dialogue & Son, Camden, N. J.
Cramp Shipbuilding Co., Philadelphia, Pa.
Union Dry Dock Co., Buffalo, N. Y.
Jackson & Sharp Co., Wilmington, Del.
Neafie & Levy Shipbuilding Co., Philadelphia, Pa.
Globe Iron Works, Cleveland, Ohio.
Cleveland Shipbuilding Co., Cleveland, Ohio.
Craig Shipbuilding Co., Toledo, Ohio.
John E. Monk, Sandusky, Ohio.
Chicago Shipbuilding Co., Chicago, Ill.
Detroit Dry Dock Co., Detroit, Mich.
James Davidson, Bay City, Mich.
F. W. Wheeler & Co., Bay City, Mich.
Jenk's Shipbuilding Co., Port Huron, Mich.
Newport News Shipbuilding and Dry Dock Co., Newport News, Va.
W. D. Crammond, Hawesville, Ky.
Union Iron Works, San Francisco, Cal.
Hall Bros., Port Blakely, Washington.

SHIP-CHANDLERS.

L. W. Ferdinand & Co., Boston, Mass.
De Grauw & Aymar, 34, 35 South St., New York City.
Howard H. Baker & Co., 18–26 Terrace, Buffalo, N. Y.
W. T. Barrutio & Co., 119 S. Fourth St., Philadelphia, Pa.
Upsom-Walton Co., 155–63 River St., Cleveland, Ohio.
South Chicago Ship Chandlery Co., 170 92d St., S. Chicago, Ill.
Woodward, Wight & Co., Canal St., New Orleans, La.

SKYLIGHTS.

Canton Steel Roofing Co., Canton, Ohio.
Jas. A. Miller & Bros., 129–131 S. Clinton St., Chicago, Ill.

STANDPIPES.

Cunningham Iron Co., Boston, Mass.
E. Hodge & Co., E. Boston, Mass.
R. D. Wood & Co., 400 Chestnut St., Philadelphia, Pa.
Riter & Conley, Pittsburg, Pa.
Sharon Boiler Works, Sharon, Pa.
Enterprise Boiler Co., Youngstown, Ohio.
Brownell & Co., Dayton. Ohio.

The Challenge Wind-mill and Feed-mill Co., Batavia, Ill.
Harvey Boiler Works, Harvey, Ill.

See ENGINES and BOILERS.

STEAM-GAUGES.

See GAUGES.

STEAM-HAMMERS.

See POWER HAMMERS.

STEAM-PIPES.

See PIPES.

STEAM-PUMPS.

See "PUMPING MACHINERY."

STEAM-REGULATING APPARATUS.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Mason Regulator Co., Boston, Mass.
Chapman Valve Mfg. Co., 72 Kilby St., Boston, Mass.; 28 Platt St., New York City; 24 W. Lake St., Chicago, Ill.
Hohmann & Maurer Mfg. Co., Plymouth and Jay Sts., Brooklyn, N. Y.
Harrison Safety Boiler Works, Philadelphia, Pa.
Sherwood Mfg. Co., Buffalo, N. Y.
Reliance Gauge Co., Cleveland, Ohio.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Detroit, Mich.
L. M. Rumsey Mfg. Co., 810 N. 2d St., St. Louis, Mo.

STEAM SHOVELS.

John Souther & Co., Boston, Mass.
New York Dredging Co., New York City.
Osgood Dredge Co., Albany, N. Y.
Thos. Carlin's Sons, Allegheny, Pa.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.
F. C. Austin Mfg. Co., Chicago, Ill.
Bucyrus Steam Shovel Co., S. Milwaukee, Wis.
San Francisco Bridge Co., San Francisco, Cal.; Seattle, Washington.

See also DREDGING MACHINERY.

STEEL.

Abbott, Wheelock & Co., Boston and New York City.
Kayser, Ellison & Co., 31 Oliver St., Boston, Mass.; 93 Liberty St., New York City.
Frankford Steel Co., Frankford, Philadelphia, Pa.
Chester Steel Casting Co., 407 Liberty St., Philadelphia, Pa.
La Belle Steel Co., Pittsburg, Pa.
Carbon Steel Co., Pittsburg, Pa.
Ætna Standard Iron & Steel Co., Bridgeport, Ohio.
Bethlehem Iron Co., S. Bethlehem, Pa.
Midvale Steel Co,, Midvale, Pa.
Russell Wheel and Foundry Co., Detroit, Mich.
Wm. E. Stockton, 16–18 W. Lake St., Chicago, Ill.
Illinois Steel Co., South Chicago, Ill.
Union Steel Co., St. Louis, Mo.

See also CASTINGS and FORGINGS.

STEEL CASTINGS.

See CASTINGS.

STEEL FORGINGS.

See FORGINGS.

STEEL RAILS.

See RAILS.

STEEL, TOOL.

B. M. Jones & Co., 11–13 Oliver St. Boston, Mass.; 143 Liberty St., New York City.
Frankford Steel Co., Frankford, Philadelphia, Pa.
La Belle Steel Co., Pittsburg, Pa.
Wm. E. Stockton, 16–18 W. Lake St., Chicago, Ill.

STEEL AND STEEL TIRED WHEELS.

See WHEELS.

STONE AND SLATE.

Bodwell Granite Co., Rockland, Me.
Brownville Maine Slate Co., Worcester, Mass.
Booth Bros., 60 Bank St. N. Y. City.
Branford Granite Co., 2 & 4 Court Square, Brooklyn, N. Y.
New England Granite Works, Hartford, Conn.
Stony Brook Felsite Quarry Co., 31 State St., Boston, Mass.
Empire Granite Co., 35 Tweddle Bldg., Albany, N. Y.; Philadelphia, Pa.
Cleveland Stone Co., Welshire Bldg., Cleveland, Ohio.
Portage Entry Quarries Co., Chicago, Ill.
Amberg Granite Co., Amberg, Wis.
Grafton Quarry Co,, 415 Locust St., St. Louis, Mo.
Guilford & Waltersville Granite Co., Baltimore, Md.
Richmond Granite Co., Richmond, Va.
Southern Granite Co., Atlanta, Ga.

STREET SWEEPERS.

See ROAD SWEEPERS.

STRUCTURAL IRON WORKS.

Berlin Iron Bridge Co., E. Berlin, Conn.
Continental Iron Works, Brooklyn, N. Y.
Jas. G. Lindsay & Co., 133 S. 4th St., Philadelphia, Pa.
Carnegie, Phipps & Co., 48 Fifth Ave., Pittsburg, Pa.
Pencoyd Iron Works, 261 S. 4th St., Philadelphia, Pa.
Russel Wheel and Foundry Co., Detroit, Mich.
Colorado Iron Works, Denver, Col.
Maryland Steel Co. Sparrows Pt., Maryland.
Tredegar Iron Works, Richmond, Va.
Colorado Iron Works, Denver, Colo.

See also BRIDGES AND BUILDING MATERIALS.

SWITCHES.

See FROGS.

TACKLE BLOCKS.

See CRANES.

TANKS—IRON AND WOOD.

Continental Iron Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.
Williams Mfg. Co. (Wood), Kalamazoo Mich.
U. S. Wind Engine and Pump Co., Batavia, Ill.

See also STAND-PIPES.

TENTS.

Horstman & Co., Cherry St., Philadelphia, Pa.
Geo. B. Carpenter & Co., 207–209 S. Water St., Chicago, Ill.
American Tent & Awning Co., St. Louis, Mo.

TESTING-MACHINES.

Riehle Bros., 9th St., Philadelphia, Pa.; 93 Liberty St., N. Y. City.
Olsen & Co., Philadelphia, Pa.

THERMOMETERS.

Standard Thermometer Co., "John Hancock" Bldg., Boston, Mass.; 14 Cortlandt St., N. Y. City.
Bristol Co., Waterbury, Conn.; 120 Liberty St., N. Y. City.

TILES.

See BRICKS.

TIMBER.

See LUMBER.

TOOLS.

R. H. Brown & Co., New Haven, Conn.
Standard Tool Co., Athol, Mass.

See also HARDWARE.

TOOLS, BLACKSMITHS', ETC.

Butts & Ordway, Boston, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Buffalo Forge Co., Buffalo, N. Y.; 22 & 24 W. Randolph St., Chicago.

Fayette R. Plumb, Philadelphia, Pa.
Oster Mfg. Co., Cleveland, Ohio.
See also HARDWARE.

TRANSMISSION MACHINERY.

C. W. Hunt, 45 Broadway, N. Y. City.
Link Belt Engineering Co., Nicetown, Philadelphia.
Fraser & Chalmers, Chicago, Ill.
Dodge Mfg. Co., Mishawaka, Ind.
Robt. Poole Son Company, Baltimore, Md.
See also CABLE RAILWAY PLANTS.

TRENCH MACHINES.

See DITCHING MACHINES.

TROWELS.

Henry Disston, Philadelphia, Pa.

TUBES.

See BOILER FRONTS AND FITTINGS.

TUBE EXPANDERS.

Richard Dudgeon, 24 Columbia St., N. Y. City.
Thos. Prosser & Son, 15 Gold St., N. Y. City.

TURBINES.

See WATER WHEELS.

TURNBUCKLES.

Merrill Bros., 465–471 Kent Ave., Brooklyn, N. Y.
Cleveland City Forge and Iron Co., Cleveland, Ohio; 136 Liberty St., N. Y. City.

TURNTABLES.

Wm. Sellers & Co., Philadelphia, Pa.
Tippett & Wood, Phillipsburg, New Jersey.

TWIST DRILLS.

Morse Twist Drill and Machine Co., New Bedford, Mass.
New Process Drill Co., Taunton, Mass.
The Cleveland Twist Drill Co., Cleveland, Ohio.
The Standard Tool Co., Cleveland, Ohio.

VALVES—GAS, STEAM, WATER.

Chapman Valve Mfg. Co., 72 Kilby St., Boston, Mass.; 28 Platt St., N. Y. City; 24 W. Lake St., Chicago, Ill.
Eynon-Evans Mfg. Co., Philadelphia, Pa.
Lunkenheimer Co., Cincinnati, Ohio.
Crosby Steam Gauge and Valve Co., Boston, Mass.; N. Y. City; Chicago, Ill.
L. M. Rumsey Mfg. Co., St. Louis, Mo.
See also ENGINE SUPPLIES and HYDRANTS.

VENTILATING APPLIANCES.

B. F. Sturtevant Co., 34 Oliver St., Boston, Mass., 91 Liberty St., N. Y. City; 135 N. 3d St., Philadelphia, Pa.; 16 S. Canal St., Chicago, Ill.
Howard & Morse, 45 Fulton St., N. Y. City.
Buffalo Forge Co., Buffalo, N. Y.
Huyett & Smith Mfg. Co., Detroit, Mich.

VISES.

Prentiss Vise Co., 44 Barclay St., N. Y. City.
Howard Iron Works, Buffalo, N. Y.
Logan & Strobridge Iron Co., New Brighton, Pa.
Hollands Mfg. Co., Erie, Pa.

WASHERS.

See BOLTS.

WATER-GAUGES.

See GAUGES.

WATER-METERS.

See METERS.

WATER-MOTORS.

See MOTORS.

WATER-TANKS.

See TANKS.

WATER-TUBE BOILERS.

See BOILERS.

WATER-WHEELS.

Dayton Globe Iron Works, Dayton, Ohio.
R. D. Wood & Co., 400 Chestnut St., Philadelphia, Pa.
S. Morgan Smith, York, Pa.
Fraser & Chalmers, Chicago, Ill.
Robert Poole Son Company, Baltimore, Md.
Pelton Water Wheel Co., 121 Main St., San Francisco.

WELLS AND WELL SUPPLIES.

U. S. Wind Engine and Pump Co., Batavia, Ill.
Cook Well Co., St. Louis, Mo.

WHEELS.

Ramapo Iron Works, Hillburn, N. Y.
Prosser & Son, 15 Gold St., N. Y. City.
Standard Steel Works, Philadelphia, Pa.
Allen Paper Car Wheel Co., Chicago, Ill.
Madison Car Co., St. Louis, Mo.
Tredegar Iron Works, Richmond, Va.
Memphis Car and Foundry Works, Memphis, Tenn.
See also RAILWAY SUPPLIES.

WHEELBARROWS.

G. L. Steubner & Co., L. I. City, N. Y.
Cockburn Barrow and Machine Co., Jersey City, N. J.
Bryan Mfg. Co., Bryan, Ohio.
Sidney Steel Scraper Co., Sidney, Ohio.
Withington & Cooley Mfg. Co., Jackson, Mich.

WIRE.

Wright & Colton Wire Cloth Co., Worcester, Mass. 181 Lake St., Chicago, Ill.
R. H. Wolff & Co., 118th St., N. Y. City.
Wetherill Bros., 93 Liberty St., N. Y. City.
Murray, Austin & Co., Philadelphia, Pa.
Trenton Iron Co., Trenton, N. J.
Baackes & Co., Pittsburg, Pa.; Cleveland, Ohio.
See also WIRE GOODS.

WIRE GOODS.

American Wire Goods Co., Lowell, Mass.
Clinton Wire Cloth Co., Clinton, Mass.
Edw. Darby & Sons, Philadelphia, Pa.
Kilmer Mfg. Co., Newburg, N. Y.; 21 Quincy St., Chicago, Ill.
W. S. Tyler Wire Works Co., Cleveland, Ohio.
E. T. Barnum, Detroit, Mich.
Ludlow-Saylor Wire Co., St. Louis, Mo.
California Wire Works, San Francisco, Cal.

WIRE NAILS.

See NAILS.

WIRE ROPE.

See CABLE.

WOOD-PRESERVING.

See CREOSOTING.

WOOD-WORKING MACHINERY.

Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Stow Flexible Shaft Co., Philadelphia, Pa.
Cleveland Wood Turning Co., Cleveland, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.
See also MACHINERY.

WRENCHES.

Bemis & Call Hardware and Tool Co., Springfield Mass.
Coes Wrench Co., Worcester, Mass.
Edw. Wright, Worcester, Mass.
Walworth Mfg. Co., Boston, Mass.
Williamsport Wrench Co., Williamsport, Pa.
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YACHTS, STEAM.

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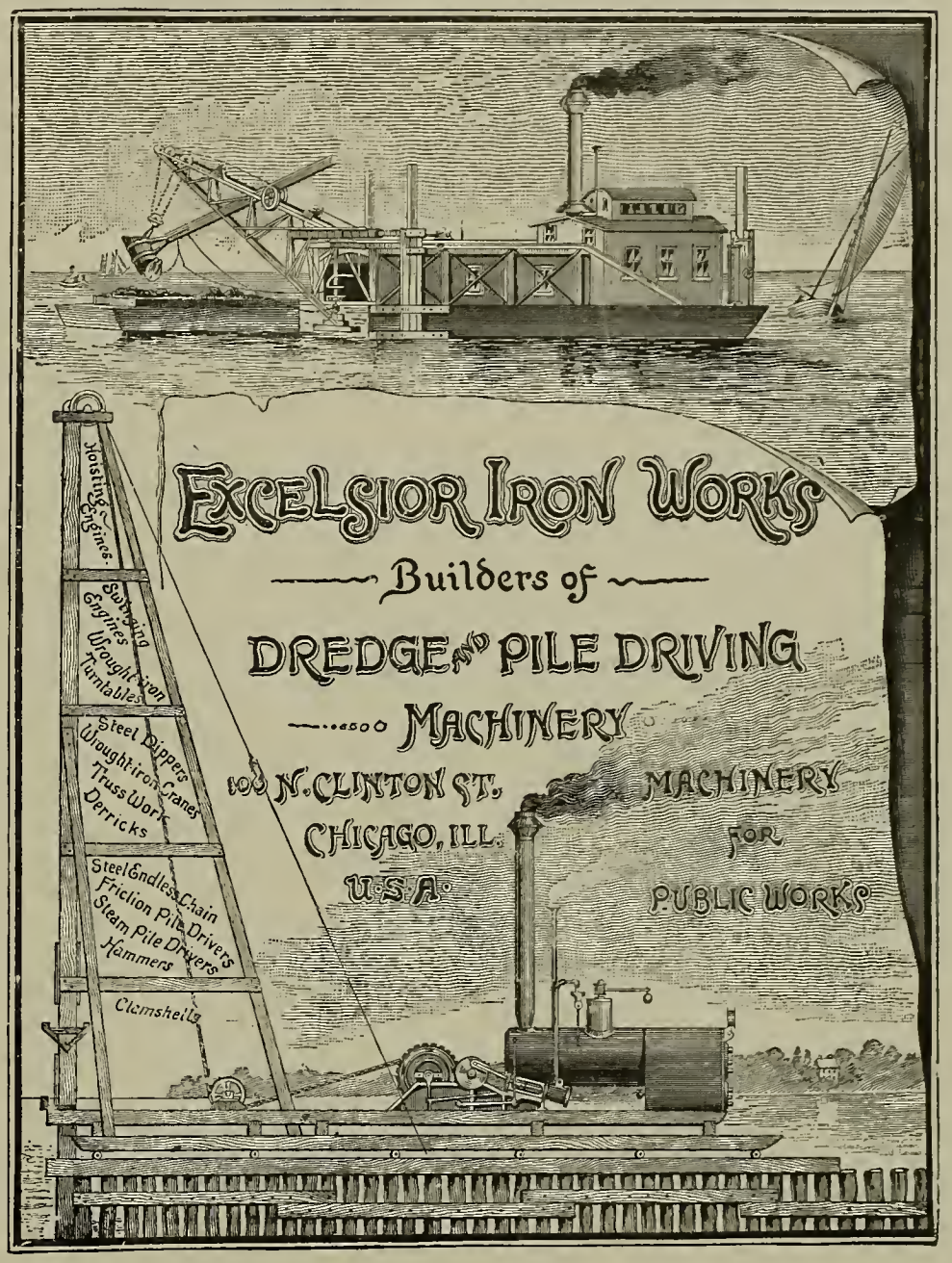

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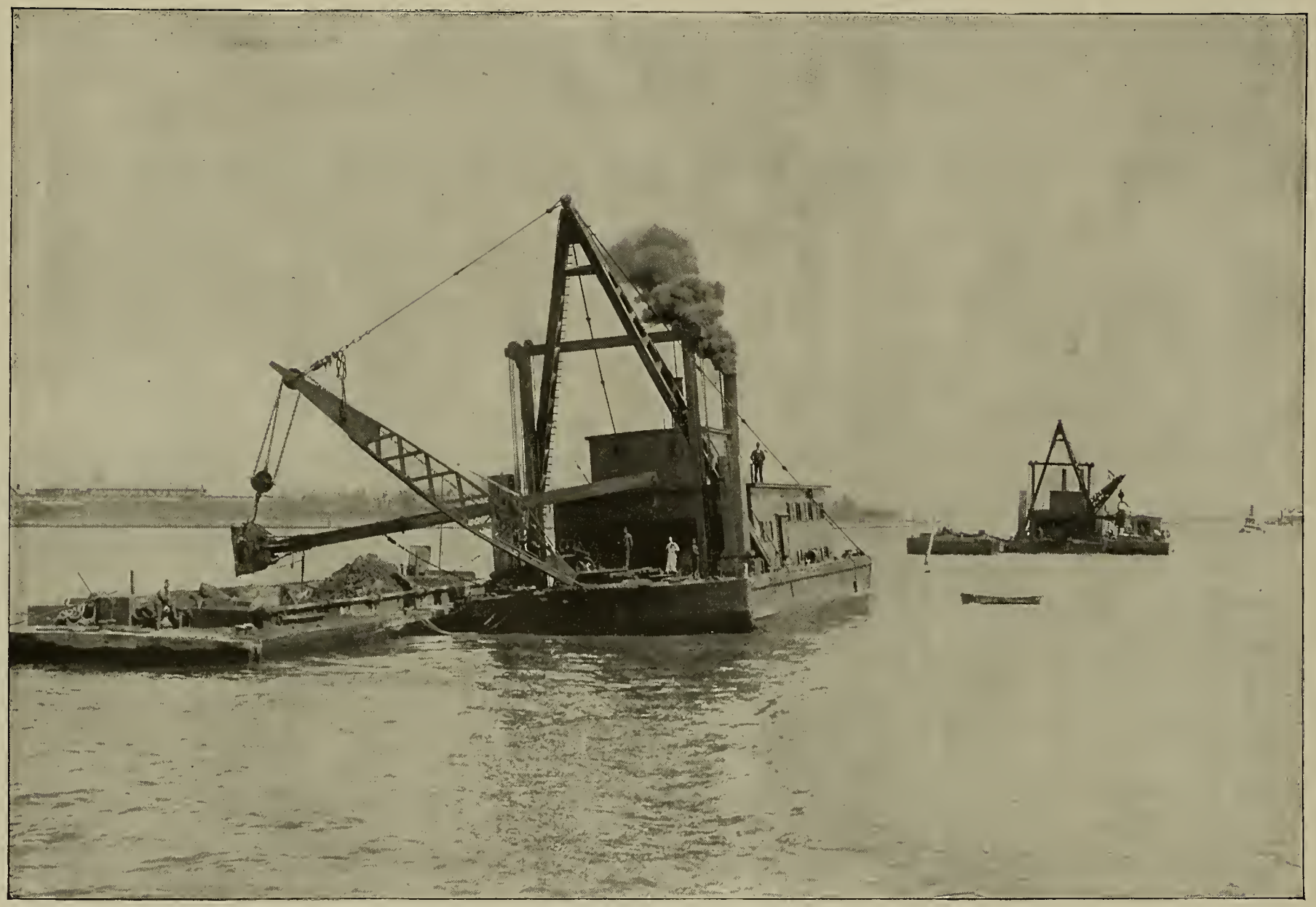

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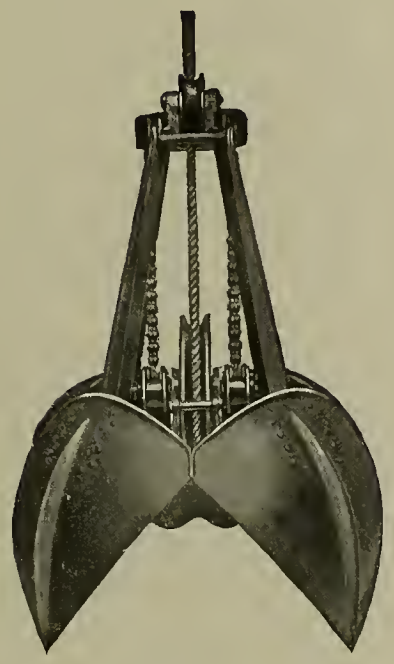

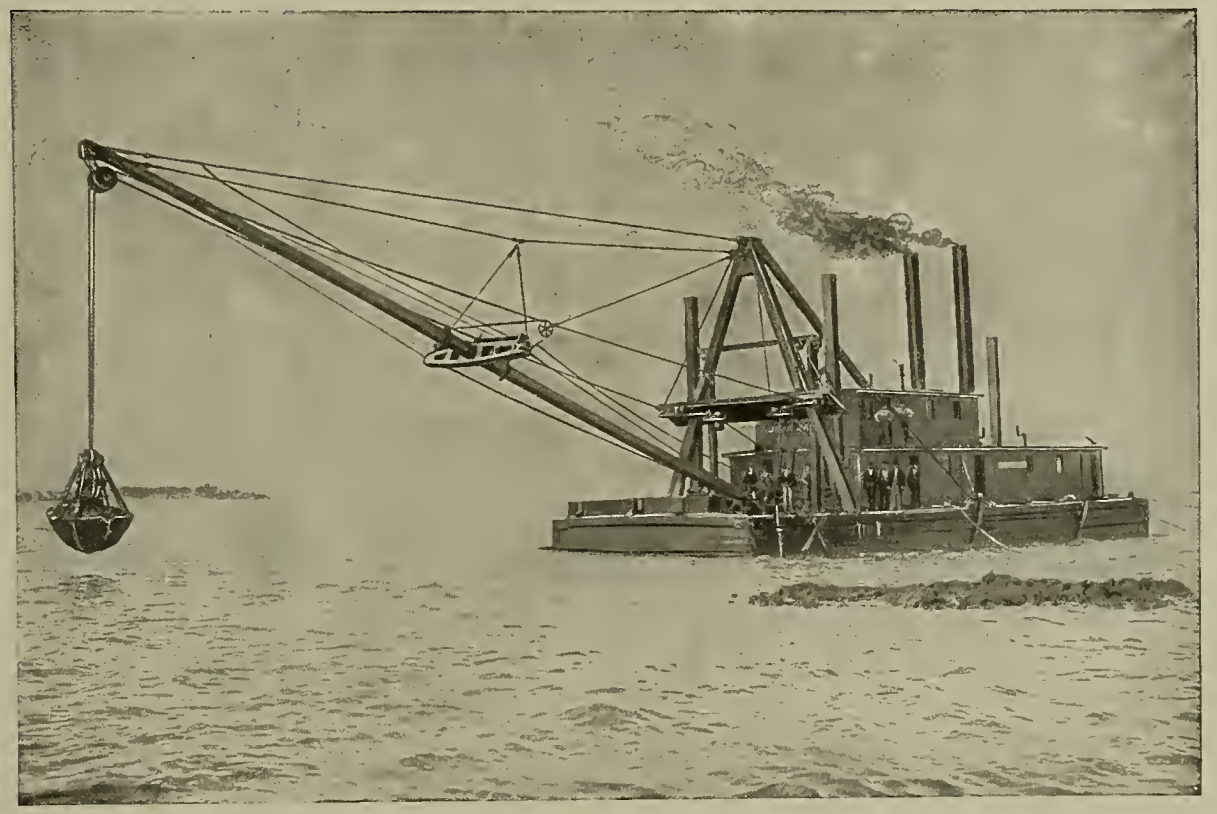

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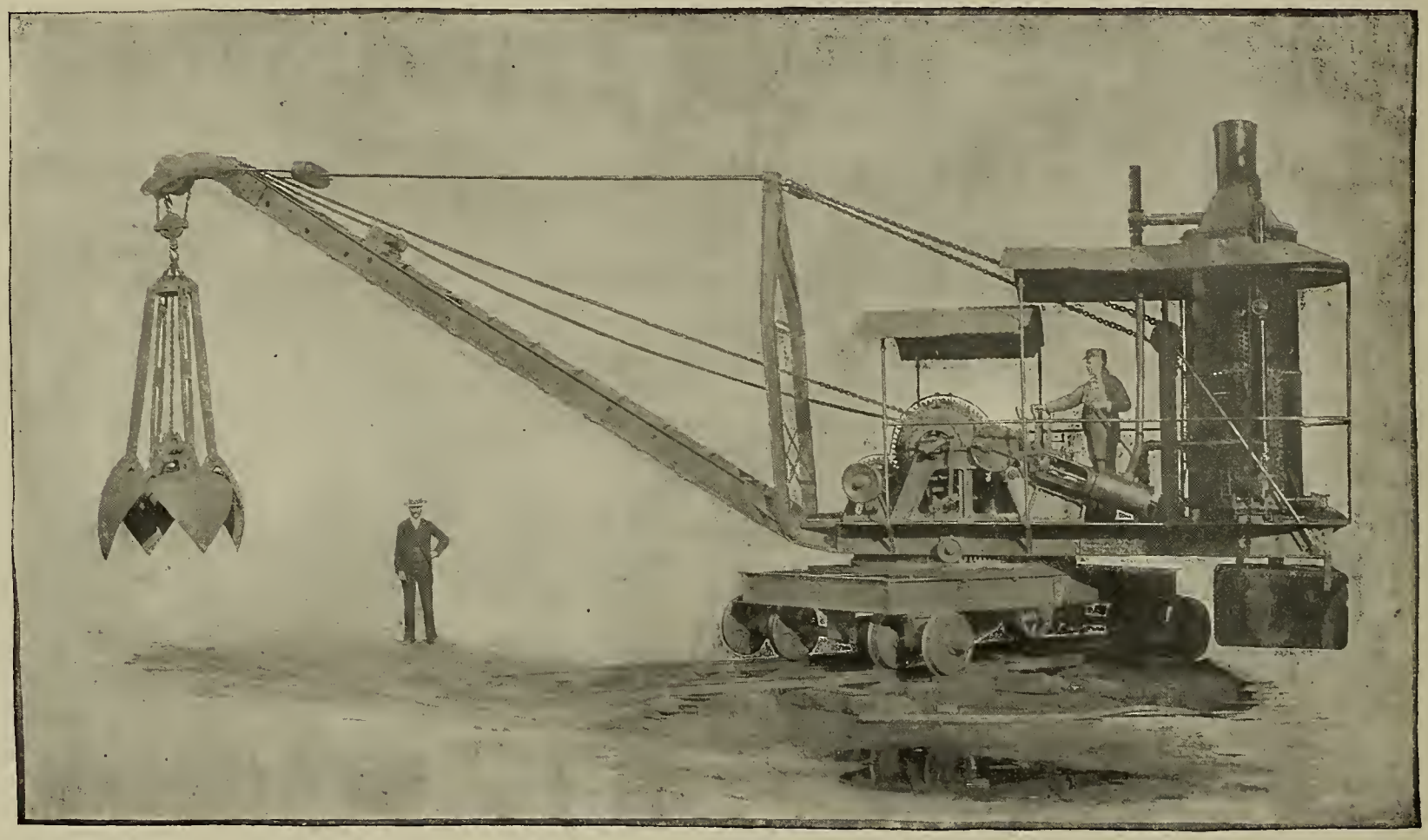

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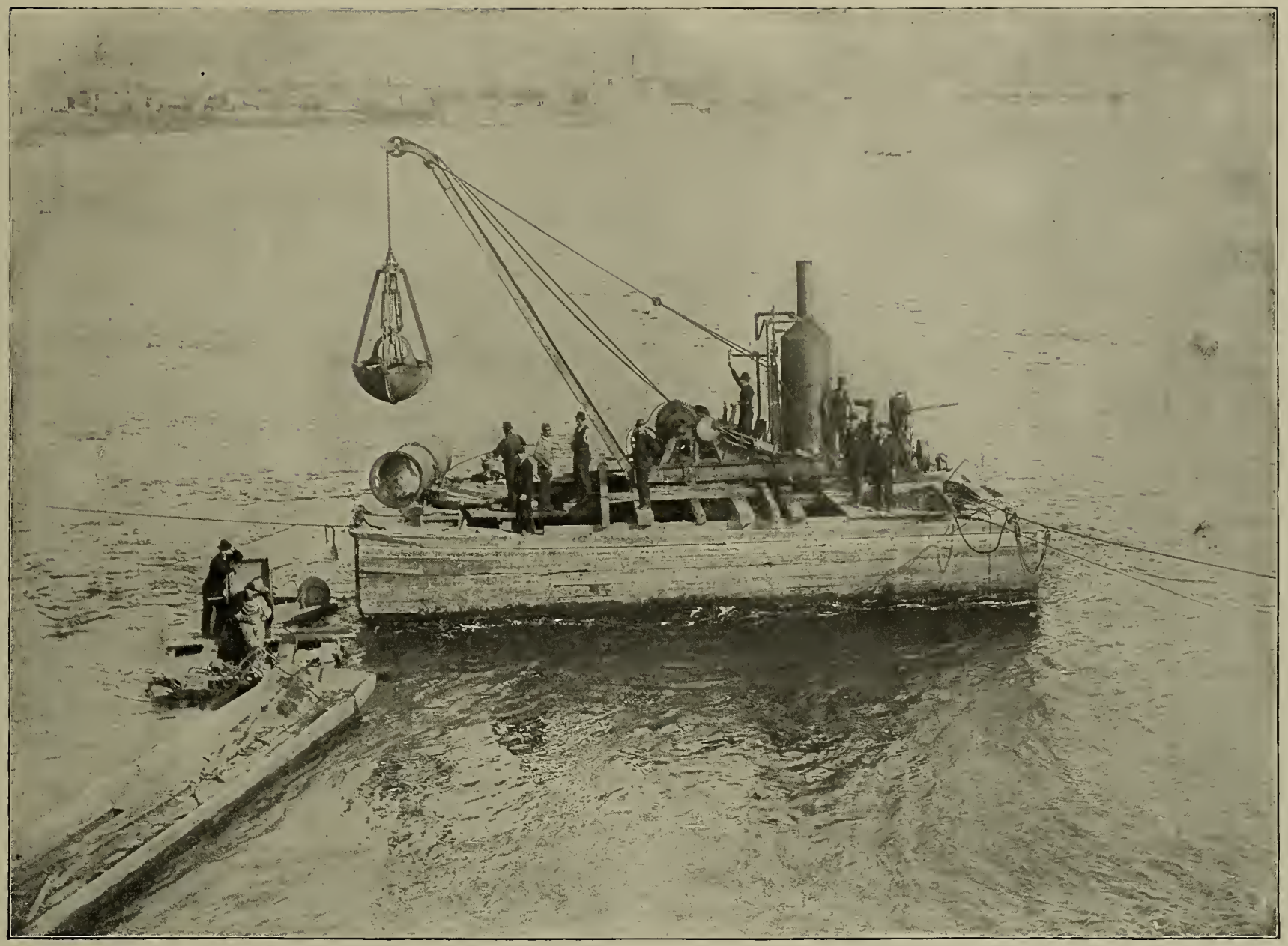

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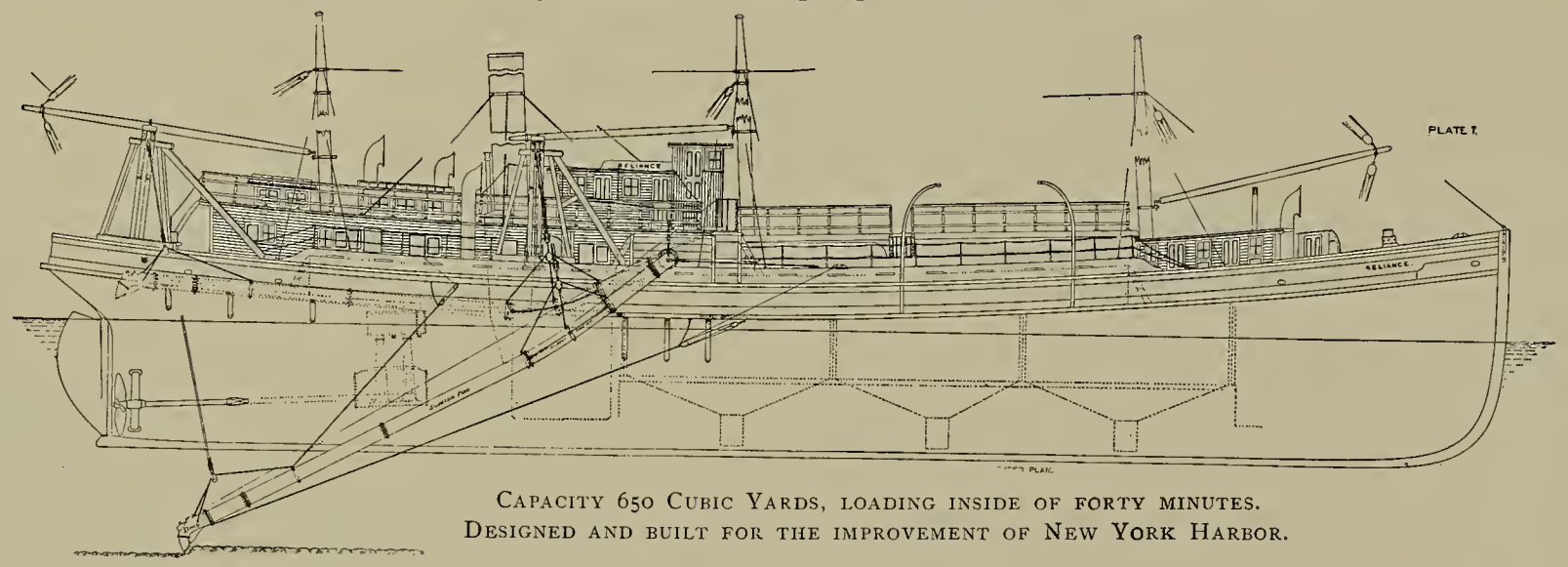

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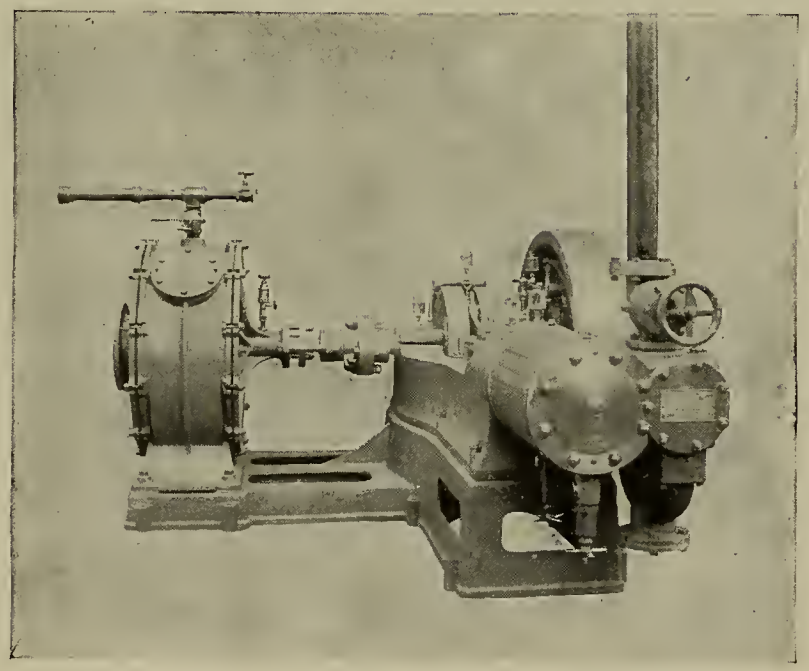

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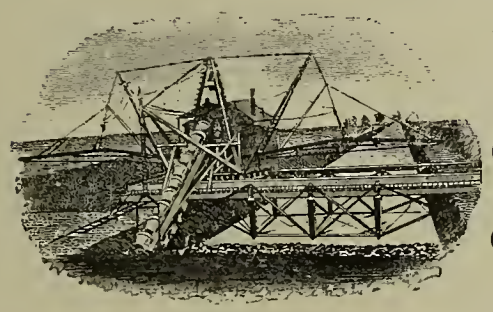

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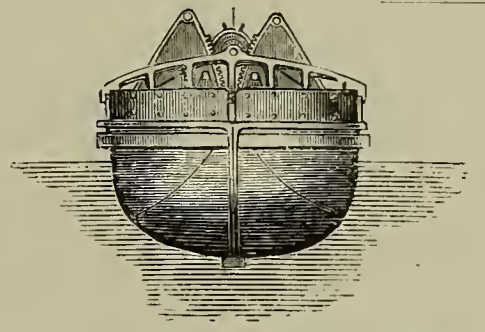
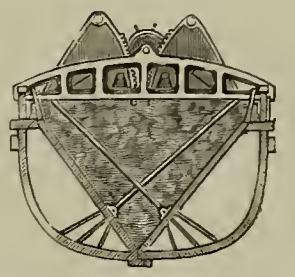
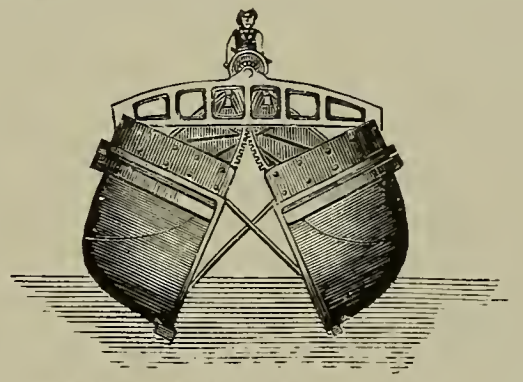


This cut shows end view bow of boat and water line, when loaded.



Cross-section of boat showing the load in place, between the pontoons, and the tension-rods which hold the pontoons together at the bottom when loaded.



Shows the boat after the load is dumped, and while being held open by the man on centre bridge, to allow the space to be thoroughly washed. When open, a clear space is shown from stem to stern, the sides of sloping well being nearly vertical.

The Advantages of these are as follows :

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THIRD.—Submerging the load six feet below the surface of the water.

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No. Slates in a sq. 3-in. lap	Sizes	Price per Sq		No. Slates in a sq. 3-in. lap.	Sizes	Price per Sq	
		No. 1	No. 2			No. 1	No. 2
686	9x 7	$4 20		202	16x11	$7 50	$6 00
515	10x 8	5 30	$4 00	185	16x12	7 50	6 00
515	11x 7	5 50	4 00	139	16x16	7 30	5 80
450	11x 8	5 60	4 10	214	18x 9	7 60	6 10
534	12x 6	5 80	4 30	192	18x10	7 50	6 00
458	12x 7	6 20	4 70	175	18x11	7 30	5 80
400	12x 8	6 30	4 80	160	18x12	7 30	5 80
356	12x 9	6 40	4 90	138	18x14	7 10	5 60
320	12x10	6 40	4 90	170	20x10	7 30	5 80
374	14x 7	6 80	5 30	154	20x11	7 20	5 70
328	14x 8	6 90	5 40	142	20x12	7 10	5 60
291	14x 9	6 90	5 40	121	20x14	7 10	5 60
262	14x10	7 00	5 50	138	22x11	7 00	5 50
219	14x12	6 90	5 60	127	22x12	6 90	5 40
187	14x14	6 70	5 20	109	22x14	6 80	5 30
277	16x 8	7 80	6 30	115	24x12	6 90	5 40
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Insoluble residue - - - - -	.61
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New York, 1894.

The reading matter in ENGINEERING NEWS occupies each week 24 quarto pages, and, besides numerous illustrations in the text, each number is supplemented by an inset sheet of drawings (generally 14 × 21 inches). Sixteen of these pages are given up to articles of technical interest, letters, editorial comments, and reviews of books. The aim is to cover what is most important in the whole field of Engineering; and while most space is given to (so-called) Civil Engineering, it will be found that Mechanical (including Electrical) Engineering receives much attention. The remaining eight pages contain matter of more transitory interest, and are now made up separately so that they need not be bound in the yearly volumes. Personal items and short notices of new publications, and of the meetings of societies, are given space in this supplement, while over six pages of small solid type are filled with reliable items relating to projected work in all parts of the United States and Canada. These items number from five to eight hundred each week, and their value to contractors and engineers cannot be overestimated.

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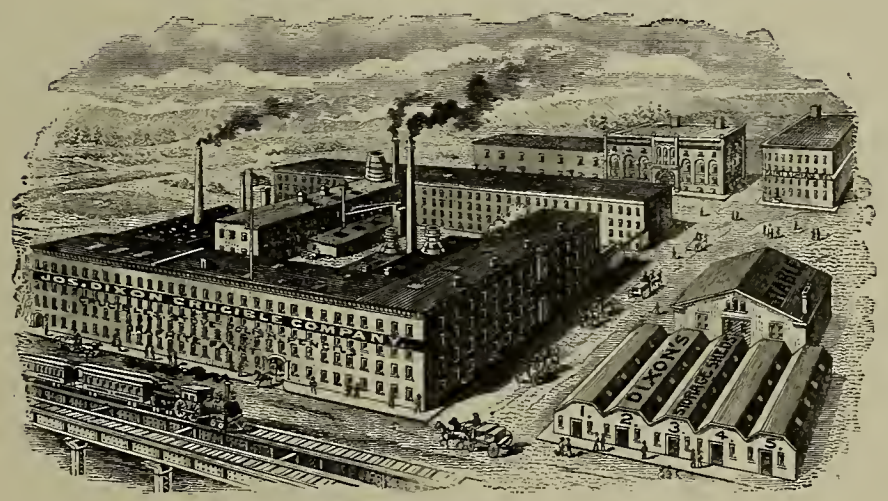

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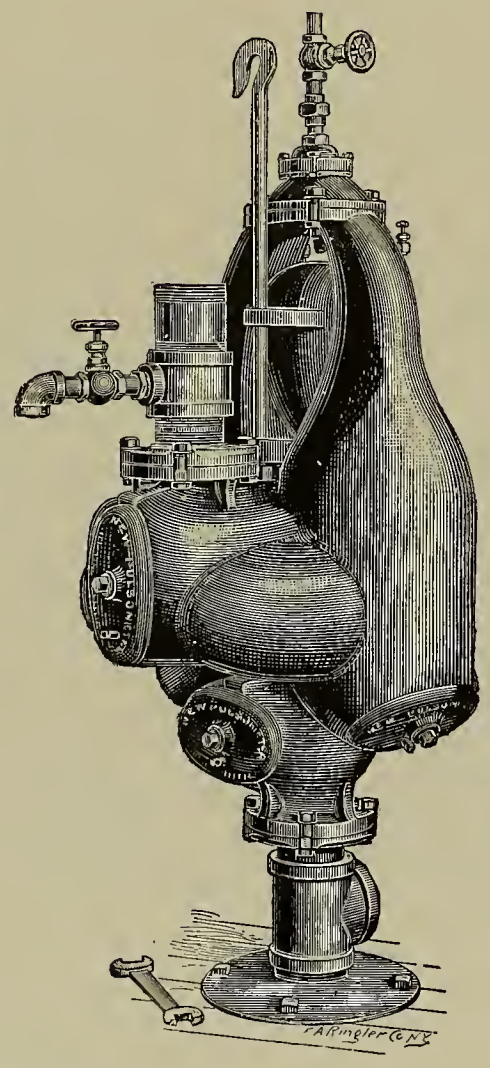

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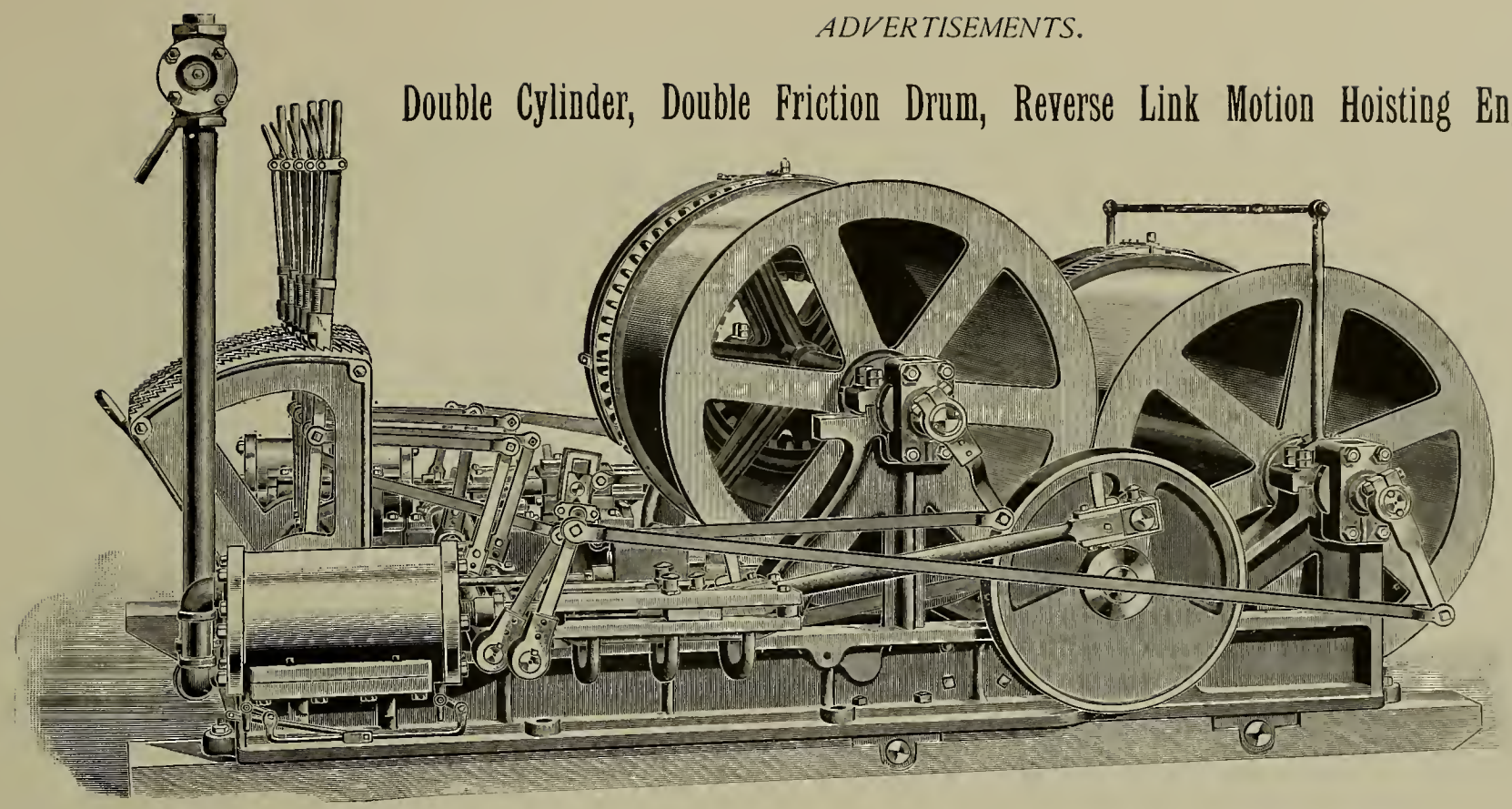

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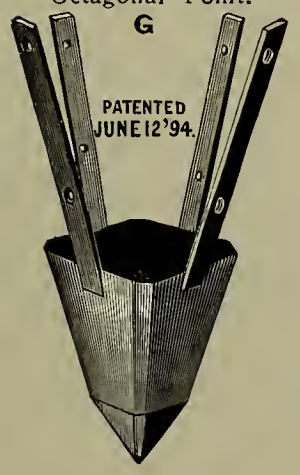

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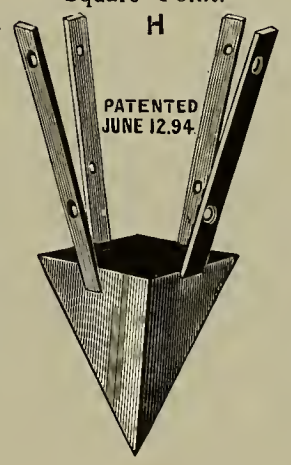

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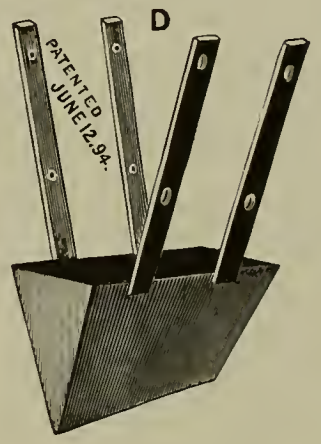

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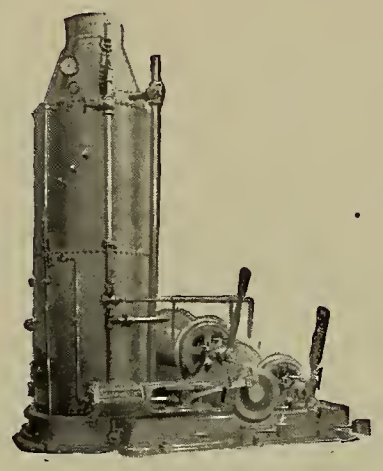

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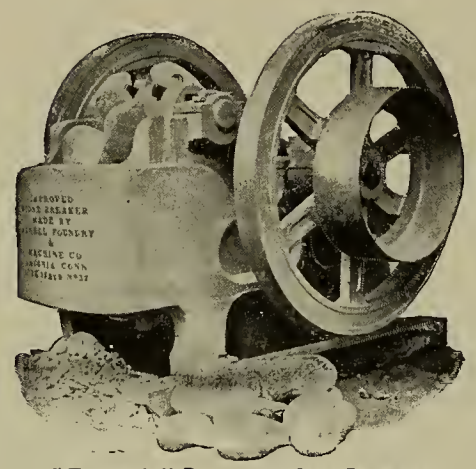

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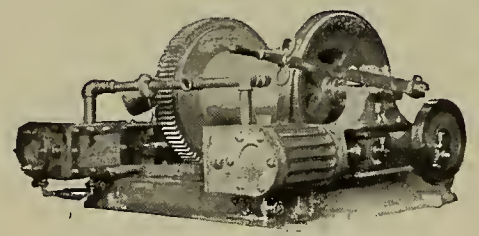

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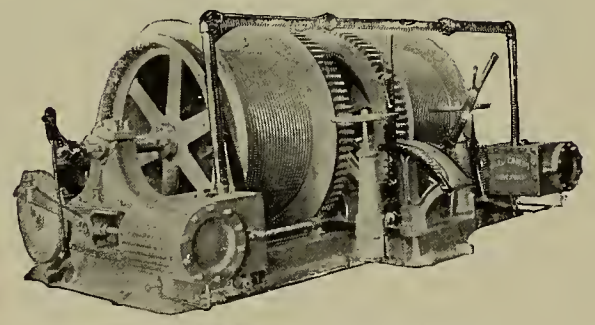

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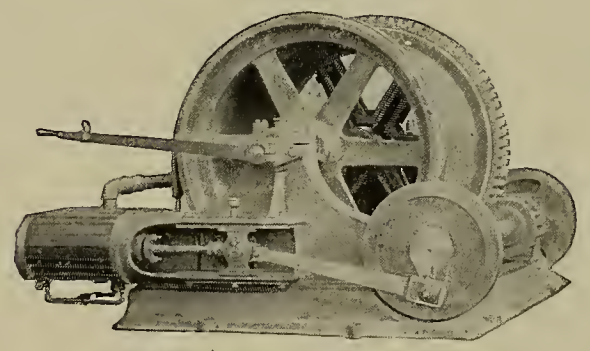

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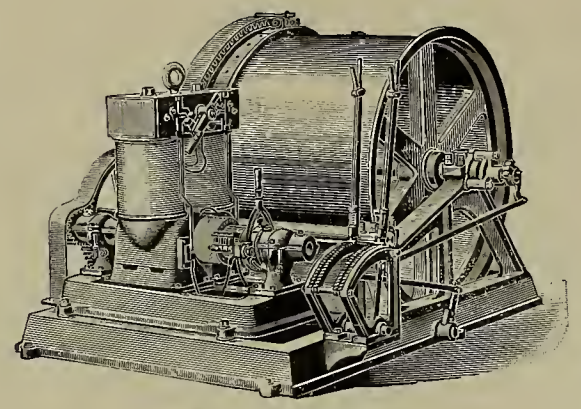

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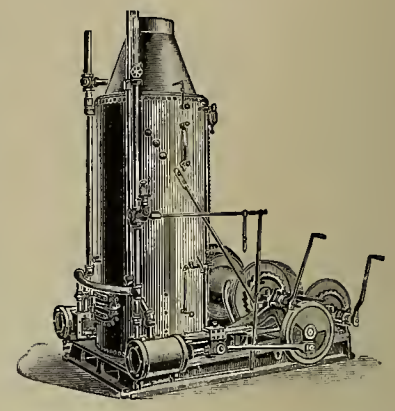

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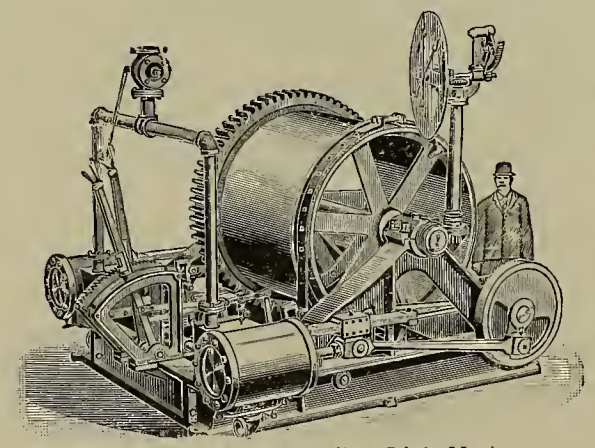

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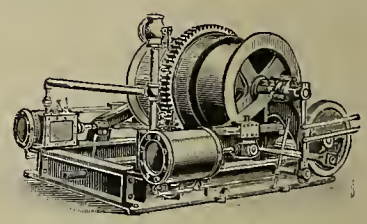

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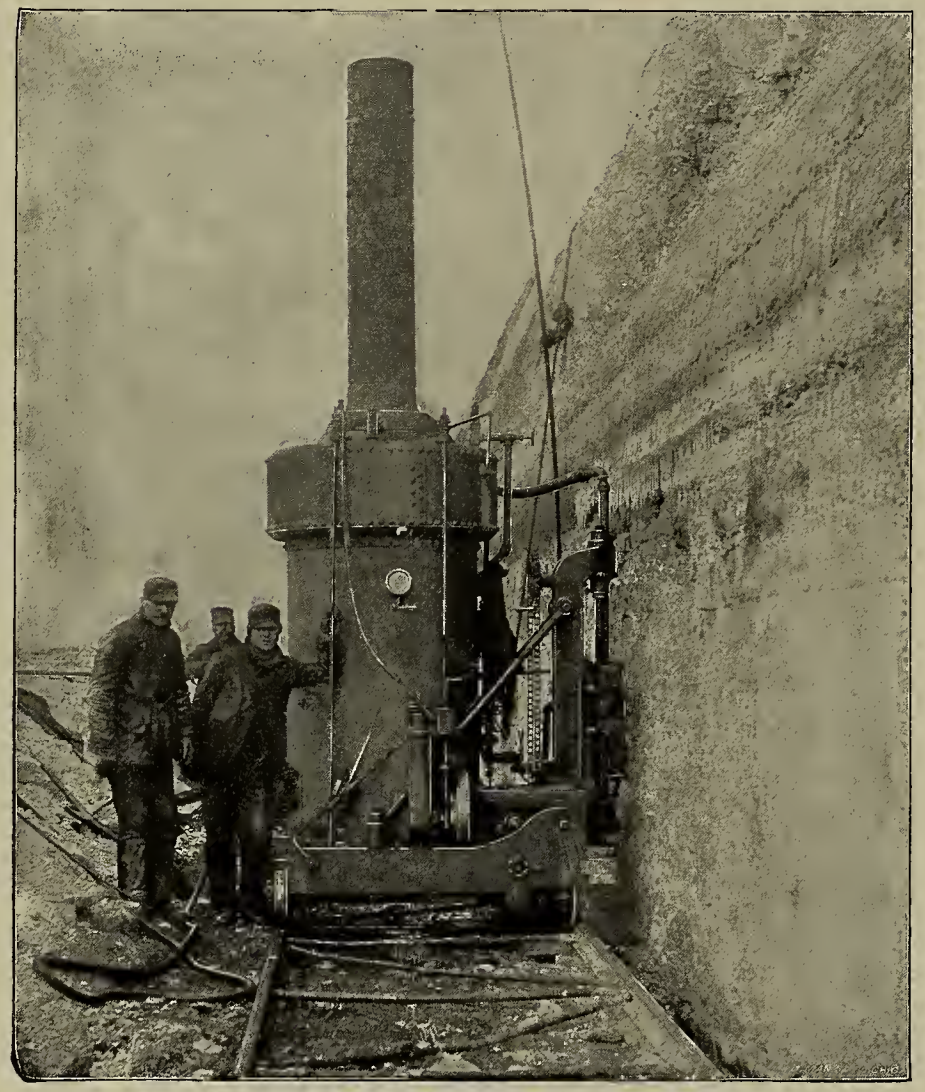

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